From the collection of the

Prelinger Library

San Francisco, California
2006

73d Congress } SENATE { Document
1st Session } { No. 12

A NATIONAL PLAN FOR AMERICAN FORESTRY

LETTER

FROM

THE SECRETARY OF AGRICULTURE

TRANSMITTING IN RESPONSE TO

S. Res. 175

(SEVENTY-SECOND CONGRESS)

THE REPORT OF THE FOREST SERVICE OF THE
AGRICULTURAL DEPARTMENT ON THE
FOREST PROBLEM OF THE
UNITED STATES

IN TWO VOLUMES

VOLUME II

Index in back of Volume II

◆

March 13 (calendar day, March 30), 1933.—Referred to
the Committee on Printing

UNITED STATES
GOVERNMENT PRINTING OFFICE
168342 WASHINGTON : 1933

SENATE RESOLUTION NO. 57

Submitted by Mr. Copeland

In the Senate of the United States,
March 13 (calendar day, April 4), 1933.

Resolved, That the report of the Department of Agriculture entitled "A National Plan for American Forestry," transmitted to the Senate on March 30, 1. 33, in response to Senate Resulution 175, Seventy-second Congress, be printed, with illustrations, as a Senate document.

Attest:

Edwin A. Halsey,
Secretary.

For sale by the Superintendent of Documents, Washington, D.C.
Price $1.75 per set of 2 volumes.

CONTENTS OF VOLUME II

Page

Federal and State aid ---- 1051
  Federal financial and other direct aid to the States ---- 1095
  The national forests as a form of Federal aid to the States ---- 1095
  Federal aid in organizaing forest credit facilities ---- 1125
  Other Federal forest activities as forms of State aid ---- 1135
  Public acquisition of private lands as an aid to private forestry ---- 1147
  State aid to private owners and local political units ---- 1177
  Factors affecting Federal and State aid ---- 1203
National programs required and the responsibility for them ---- 1229
  The area which can and should be used for forestry ---- 1231
  Future adjustments in land use and ownership ---- 1241
  The probable future distribution of forest land ownership ---- 1253
  Ownership responsibilities, costs, and returns ---- 1303
  A program for direct Federal and State aid ---- 1329
  A possible program for public regulation ---- 1343
  Enlarging the consumption of forest products ---- 1355
  Protection against fire ---- 1395
  Protection against forest insects ---- 1415
  Protection against forest diseases ---- 1419
  How to stop forest devastation ---- 1429
  A program for intensive forest management ---- 1455
  Reforestation of barren and unproductive land ---- 1485
  A watershed protection program ---- 1509
  A forest range program ---- 1537
  A program for forest recreation ---- 1543
  A forest wild life program ---- 1547
  A program for forest research ---- 1555
  Forest extension, an appraisal and a program ---- 1575
  The programs summarized as to costs, financing, and needed legislation ---- 1587
Appendix ---- 1639
  Alaska ---- 1641
  Puerto Rico ---- 1646
Index ---- 1653

FEDERAL FINANCIAL AND OTHER DIRECT AID TO STATES

By A. B. Hastings, in charge of State cooperation

CONTENTS

	Page
Federal aid in forest-fire protection	1054
Federal aid in farm forest planting	1076
Cooperation with States in farm forestry extension	1081
Federal aid to States for roads	1087
Federal land grants to States	1088
Federal aid to State agricultural colleges and experiment stations	1092
Vocational education	1093

The Senate resolution in response to which this report has been prepared specifically raised the question of Federal aid to the States. It is therefore fitting to outline the purposes and accomplishments of Federal aid insofar as they relate to forestry interests, in order that this form of activity may be properly appraised as a means of solving our forestry problems, now and in the future.

To summarize the status of Federal aid to States in its present financial perspective, a list of current projects is given in table 1. The total of the appropriations as shown is more than $180,000,000, and while there is no assurance that the list is complete, sufficient care has been taken to cover the major items.

Table 1.—*Federal aid appropriations for the States for the fiscal year 1933*

Project	Amount	Percent
Forest-fire prevention	$1, 611, 580	0. 88
Distribution of nursery stock	79, 960	. 04
Forestry extension	69, 850	. 04
Highways	125, 000, 000	68. 60
State fund from sale of public lands [1]	26, 185	. 01
Support of agricultural colleges	2, 550, 000	1. 40
Support of experiment stations	4, 374, 000	2. 40
Cooperative agricultural extension work	5, 760, 170	3. 16
Vocational education	8, 414, 853	4. 62
Vocational rehabilitation	1, 089, 858	. 60
National Guard	31, 263, 565	17. 16
Maternity and infant hygiene [2]	776, 576	. 42
State fund under oil-leasing act [1]	1, 213, 562	. 67
Total	182, 230, 159	100. 00

[1] Amount expended in fiscal year 1932.

[2] Amount expended in fiscal year 1929.

It is impressive to note that the sums appropriated directly to forestry work in 1933 constitute less than 1 percent of the total. Although such a ratio may roughly represent popular appreciation of the need of aid to the States in forestry, it quite certainly fails to measure the need in any real sense.

In the discussion that follows, first attention will be centered on the three specific forestry activities shown—fire prevention, distribution of nursery stock, and forestry extension. Several other activities, having rather close relationships to forestry, will then be taken up in order.

FEDERAL AID IN FOREST-FIRE PROTECTION

THE WEEKS LAW

(Act of Mar. 1, 1911; 36 Stat. 961)

The Weeks law was the first of the present-day Federal aid measures enacted by Congress which embodied the condition of equal sharing of expenditure by the States. Various forms of land grants had, of course, been made long before this. Measures had also been taken by Congress in support of State colleges of agriculture and of agricultural experiment stations. By the passage of the Weeks law a lump sum of $200,000 was made available until expended—

> to enable the Secretary of Agriculture to cooperate with any State or group of States, when requested to do so, in the protection from fire of the forested watersheds of navigable streams; and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any State or group of States to cooperate in the organization and maintenance of a system of fire protection on any private or State forest lands within such State or States and situated upon the watershed of a navigable river: *Provided*, That no such stipulation or agreement shall be made with any State which has not provided by law for a system of forest fire protection: *Provided further*, That in no case shall the amount expended in any State exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year.

During the fiscal year 1911, cooperation was undertaken with 11 States under this act. The number increased steadily to a total of 29 States in 1925, and meanwhile additional appropriations were made under the act. During the calendar year 1911, $36,692 Federal, $165,975 State, and $54,590 private money was expended upon the protection of approximately 60,779,000 acres of forested watersheds. In the fiscal year 1925, the last year prior to cooperation under the Clarke-McNary law, the corresponding amounts spent were $397,651 Federal and $1,844,192 State and private. Combined expenditures under the Weeks law were thus increased nearly tenfold from 1911 to 1925, and the area of forest land under cooperative protection in 1925 was three times that in 1911.

THE CLARKE-McNARY LAW

(Act of June 7, 1924; 43 Stat. 653)

This act continued the Federal cooperation started with the States under the Weeks law, which was superseded in that respect. It removed the limitation of protection to forested watersheds of navigable streams, provided for cooperation through the States with private forest owners, and added the important provisions contained in sections 3, 4, and 5—for forest taxation studies, for cooperation with the States in the production and distribution of forest planting stock for windbreaks, shelter belts, and farm wood lots, and for cooperation in farm forestry extension.

The following are the provisions of sections 1, 2, and 3 of the Clarke-McNary law:

> That the Secretary of Agriculture is hereby authorized and directed, in cooperation with appropriate officials of the various States or other suitable agencies, to recommend for each forest region of the United States such systems of forest fire prevention and suppression as will adequately protect the timbered and cut-over lands therein with a view to the protection of forest and water resources and the continuous production of timber on lands chiefly suitable therefor.

Sec. 2 (as amended by act of Mar. 3, 1925, 43 Stat., 1127, and act of Apr. 13, 1926, 44 Stat. 242). That if the Secretary of Agriculture shall find that the system and practice of forest fire prevention and suppression provided by any State substantially promotes the objects described in the foregoing section, he is hereby authorized and directed, under such conditions as he may determine to be fair and equitable in each State, to cooperate with appropriate officials of each State, and through them with private and other agencies therein, in the protection of timbered and forest-producing lands from fire. In no case other than for preliminary investigations shall the amount expended by the Federal Government in any State during any fiscal year, under this section, exceed the amount expended by the State for the same purpose during the same fiscal year, including the expenditures of forest owners or operators which are required by State law or which are made in pursuance of the forest protection system of the State under State supervision, and the Secretary of Agriculture is authorized to make expenditures on the certificate of the State forester, the State director of extension, or similar State official having charge of the cooperative work for the State that State and private expenditures as provided for in this Act have been made. In the cooperation extended to the several States due consideration shall be given to the protection of watersheds of navigable streams, but such cooperation may, in the discretion of the Secretary of Agriculture, be extended to any timbered or forest producing lands or watersheds from which water is secured for domestic use or irrigation within the cooperating States.

Sec. 3. That the Secretary of Agriculture shall expend such portions of the appropriations authorized herein as he deems advisable to study the effects of tax laws, methods, and practices upon forest perpetuation, to cooperate with appropriate officials of the various States or other suitable agencies in such investigations and in devising tax laws designed to encourage the conservation and growing of timber, and to investigate and promote practical methods of insuring standing timber on growing forests from losses by fire and other causes. There is hereby authorized to be appropriated annually, out of any money in the Treasury not otherwise appropriated, not more than $2,500,000 to enable the Secretary of Agriculture to carry out the provisions of sections 1, 2, and 3 of this Act.

This law was passed after a special Senate committee had made an exhaustive study of forestry needs. It was an attempt to advance the protection of forest and water resources and to provide conditions under which the practice of forestry by private owners would be freed from excessive handicaps, so that it could be undertaken profitably by the owner to the advantage of the Nation. Under the authorization of $2,500,000 annually, an initial appropriation for cooperation with the States in forest fire protection was made for the fiscal year 1926 in the amount of $660,000. For the succeeding fiscal years, appropriations have been made as follows: 1927, $710,000; 1928, $1,000,000; 1929, $1,209,802; 1930, $1,400,000: 1931, $1,700,000; 1932, $1,775,000. As an economy measure, a saving was made in the 1932 appropriation, so that the actual provision was $1,612,600.

The total amounts of Federal, State, and private money expended under these two acts from March 1, 1911, to June 30, 1932, including the amount spent for the investigations of forest taxation and forest insurance, are the following:

Weeks law	$2, 431, 378	
Clarke-McNary law	8, 355, 819	
Total Federal		$10, 787, 197
State and private under Weeks law	$12, 380, 607	
State and private under Clarke-McNary law	24, 256, 679	
Total State and private		36, 637, 286
Grand total		47, 424, 483

ADMINISTRATION OF THE ACTS

From the start the plan followed in the administration of the Weeks and Clarke-McNary laws by the Forest Service has been based upon the principle that the fire-protection work in each State would be supervised and carried through by the State. State laws govern the handling of fire and other trespass on State and private lands, the protection of which is under discussion. State and private money must be depended upon to carry most of the load. The projects are therefore conducted under State plans, which, upon approval by the Federal Government, are jointly developed by the State forester and the Federal Forest Service. Annual budgets to carry out these plans are submitted to the Forest Service for approval, as are the later reports of expenditures which form the basis for Federal reimbursement to the States.

To protect the Federal interest and to give full advantage to the States of the experience of the Forest Service and other States, Federal inspection districts corresponding in general to the forest regions have been established, with a district forest inspector in each. The inspectors in the East with headquarters at Amherst, Mass.; Washington, D.C; Asheville, N.C.; New Orleans, La.; and Louisville, Ky.; report directly to the Washington office. The inspectors in the West report to the regional foresters at Missoula, Mont.; Denver, Colo.; Albuquerque, N.Mex.; Ogden, Utah; San Francisco, Calif.; Portland, Oreg.; and Milwaukee, Wis. These inspectors keep in close touch with each State project in the field.

As a part of the fire plan for each State, careful estimates of areas in need of protection, a layout of the organization, improvements, etc., needed to accomplish adequate protection, and estimates of the cost of such protection have been formulated. The estimates of areas and costs as of 1930 are shown on table 2, columns 2 and 3. The Clarke-McNary law itself, in its authorization of Federal appropriations of $2,500,000 a year, presupposed an annual cost of approximately $10,000,000 as necessary to protect the State and private land in all States. The 1930 revision of this cost was $13,386,273. Comparative studies and analyses made in the section of this report covering Protection Against Fire indicate that if protection of all forest areas adequate to meet the standards as therein set up is to be attained within the next 10 or 15 years the annual cost would be considerably greater.

GENERAL RESULTS

FEDERAL AID AS A STIMULUS TO STATES IN ESTABLISHING AND DEVELOPING FORESTRY DEPARTMENTS

Up to 1911, when the Weeks Act was passed, only 16 States had appropriated money to engage in the protection of forests from fire. Upon passage of the act, 11 of these immediately entered into agreements with the Federal Government to cooperate in forest fire protection. The number of States cooperating in this activity in 1932 was 38, including all the original 16 and 22 others. The organized protection of privately owned forest land is known to have been initiated in at least 17 of the 22 additional States as a direct result of Federal cooperation. It is believed that in many of them forest protection would have been much longer delayed if Federal aid had not been available.

TABLE 2.—*Progress in protection of State and private forest land as shown by area and cost of acreage protected in calendar year 1915 and 1931, as compared with acreage needing protection*

Regions and States	Acreage needing protection[1]			Acreage protected 1915 and 1931					
	Forest area	Total cost	Cost per acre	Area 1915	Area 1931		Expenditures 1915	Expenditures 1931	Cost per acre 1931
(1)	(2)	(3)	(4)	(5)	(6)	(7)[4]	(8)	(9)	(10)
	Acres	*Dollars*	*Cents*	*Acres*	*Acres*	*Percent*	*Dollars*	*Dollars*	*Cents*
New England:									
Connecticut	1, 500, 000	76, 000	5. 07	1, 443, 000	1, 500, 000	100	20, 382	71, 195	4. 7
Maine	14, 957, 000	342, 000	2. 29	9, 500, 000	15, 000, 000	100	62, 635	223, 155	1. 5
Massachusetts	3, 300, 000	169, 000	5. 12	2, 500, 000	3, 300, 000	100	33, 084	130, 930	4. 0
New Hampshire	4, 259, 000	131, 000	3. 08	3, 500, 000	4, 254, 000	99	76, 601	59, 385	1. 4
Rhode Island	280, 000	17, 000	6. 07		280, 000	100		7, 287	2. 6
Vermont	3, 375, 000	57, 000	1. 69	2, 000, 000	3, 750, 000	111	7, 797	19, 379	. 5
Total	27, 671, 000	792, 000	2. 86	18, 943, 000	28, 084, 000	101	200, 499	511, 331	1. 8
Middle Atlantic:									
Delaware	325, 000	12, 000	3. 69		350, 000	107		7, 837	2. 2
Maryland	2, 200, 000	73, 000	3. 32	2, 000, 000	2, 223, 000	101	7, 858	88, 677	4. 0
New Jersey	1, 906, 000	128, 000	6. 72	1, 800, 000	1, 890, 000	99	33, 984	149, 441	7. 9
New York	11, 689, 000	378, 000	3. 23	7, 200, 000	10, 265, 000	88	197, 569	305, 835	3. 0
Pennsylvania	12, 365, 000	364, 000	2. 94		12, 627, 000	102		614, 069	4. 9
Total	28, 485, 000	955, 000	3. 35	11, 000, 000	27, 355, 000	96	239, 411	1, 165, 859	4. 3
Lake									
Michigan	18, 596, 000	662, 000	3. 56	12, 000, 000	19, 416, 000	104	67, 428	748, 817	3. 9
Minnesota	20, 523, 000	697, 000	3. 40	14, 250, 000	21, 310, 000	104	99, 569	535, 711	2. 5
Wisconsin	13, 187, 000	390, 000	2. 96	5, 000, 000	13, 374, 000	101	15, 920	384, 260	2. 9
Total	52, 306, 000	1, 749, 000	3. 34	31, 250, 000	54, 100, 000	103	182, 917	1, 668, 788	3. 1
Central:									
Illinois	2, 750, 000	77, 000	2. 80		538, 000	20		13, 600	2. 5
Indiana	3, 000, 000	84, 000	2. 80		300, 000	10		15, 118	5. 0
Kentucky	9, 000, 000	212, 000	2. 36	5, 000, 000	1, 321, 000	15	10, 609	39, 018	2. 9
Missouri	15, 750, 000	347, 000	2. 20						
Ohio	2, 160, 000	60, 000	2. 78		1, 040, 000	48		20, 102	1. 9
Tennessee	10, 430, 000	245, 000	2. 35		6, 967, 000	67		45, 357	. 6
West Virginia	9, 251, 000	312, 000	3. 37	4, 450, 000	5, 835, 000	63	17, 367	117, 083	2. 0
Total	52, 341, 000	1, 337, 000	2. 55	9, 450, 000	16, 001, 000	31	27, 976	250, 278	1. 6

[1] 1930 estimates.

[4] Percents over 100 are due to areas protected in excess of 1930 estimates of areas needing protection

TABLE 2.—*Progress in protection of State and private forest land as shown by area and cost of acreage protected in calendar year 1915 and 1931, as compared with acreage needing protection*—Continued

Regions and States (1)	Acreage needing protection[1]			Acreage protected 1915 and 1931					
	Forest area (2)	Total cost (3)	Cost per acre (4)	Area 1915 (5)	Area 1931 (6)	Area 1931 (7)[4]	Expenditures 1915 (8)	Expenditures 1931 (9)	Cost per acre 1931 (10)
	Acres	*Dollars*	*Cents*	*Acres*	*Acres*	*Percent*	*Dollars*	*Dollars*	*Cents*
South:									
Alabama	22,386,000	573,000	2.56		9,613,000	43		88,037	.9
Arkansas	22,000,000	484,000	2.20		[3] 4,206,000	19			
Florida	22,900,000	847,000	3.70		1,319,000	6		147,149	11.1
Georgia	23,100,000	775,000	3.35		1,653,000	7		102,087	6.2
Louisiana	17,900,000	434,000	2.42		5,567,000	31		135,758	2.4
Mississippi	19,500,000	563,000	2.89		520,000	3		52,168	10.0
North Carolina	20,568,000	632,000	3.07		7,594,000	37	2,339	109,552	1.4
Oklahoma	12,388,000	165,000	1.33		1,312,000	11		35,927	2.7
South Carolina	12,500,000	378,000	3.02		607,000	5		70,759	11.6
Texas	15,657,000	434,000	2.77		7,209,000	46		102,162	1.4
Virginia	14,005,000	397,000	2.83		8,583,000	61	1,878	100,356	1.2
Total	202,904,000	5,682,000	2.80		48,183,000	24	4,217	943,955	2.1
Pacific Coast:									
California	18,955,000	969,000	5.11		11,746,000	62		977,759	8.3
Oregon	10,685,000	584,000	5.47	11,586,000	13,592,000	127	129,228	579,375	4.3
Washington	12,080,000	632,000	5.23	7,500,000	10,563,000	87	85,985	502,503	4.7
Total	41,720,000	2,185,000	5.24	19,086,000	35,901,000	86	215,213	2,059,637	5.7
North Rocky Mountain:									
Idaho (north)	3,843,000	420,000	10.93	3,200,000	5,384,000	117	99,186	429,526	8.5
Idaho (south)	758,000	27,000	3.56				3,345	27,267	
Montana	4,854,000	190,000	3.91	1,700,000	7,282,000	150	8,557	147,070	2.0
Total	9,455,000	637,000	6.74	4,900,000	12,666,000	134	111,088	603,863	4.8
South Rocky Mountain:									
Arizona					[3] 383,000				
Colorado					[3] 793,000				
Nevada	[2] 315,000	13,600	4.32		533,000	169		7,853	1.5
New Mexico	1,800,000	26,000	1.44		1,375,000	76		5,331	.4
South Dakota	79,000	4,500	5.70	49,000	171,000	217	2,596	3,976	2.3
Utah					[3] 96,000				
Wyoming					[3] 170,000				
Total	2,194,000	44,100	2.01	49,000	3,521,000	95	2,596	17,160	.8
Hawaii	[2] 2,557,000	5,173	.20		1,800,000	70		1,017	.1
Grand total	419,633,000	13,386,273	3.19	94,678,000	227,611,000	54	983,917	7,221,888	3.3

---

[1] 1930 estimates.
[2] 1931 estimates.
[3] Eliminated from totals used to determine cost per acre and percent protected for groups of States and for all States.
[4] Percents over 100 are due to areas protected in excess of 1930 estimates of areas needing protection.

COVERAGE OF FOREST AREAS BY SOME DEGREE OF ORGANIZED PROTECTION

The acreages covered in the extension of systematic protection to the area needing protection are indicated for the years 1912 to 1931 in figure 1. The average annual gain in area of State and private forest land under some form of systematic protection from 1912 to 1931 was 8,781,000 acres. If this rate of progress were continued, and if it is assumed that the total area to be covered is 420,000,000 acres, complete coverage would be attained at this rate in 22 years. If we take the period 1925–30, the average annual gain indicated is 9,870,000 acres, and the time required for complete coverage is 19 years. This periodic progress is shown in relation to the estimated need in figure 2.

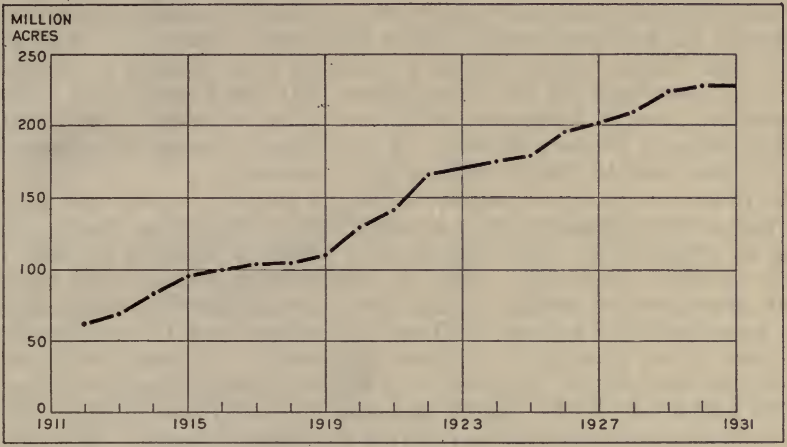

FIGURE 1.—Forest area in State and private ownership under cooperative fire protection.

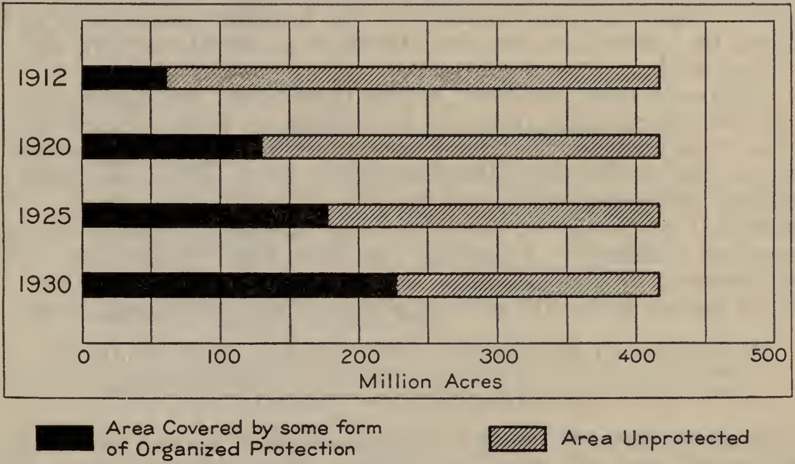

FIGURE 2.—Progress in protection of State and private forest land from fire on basis of area.

A study of table 2, columns 5 and 6, will disclose the striking contrast between the areas protected in 1915 and in 1931. The percentage of total coverage increased from 23 to 54. But forecasts based on total or average progress to date mean little. It is more significant to consider what may happen in the particular areas where increases in protection, if any, must occur. Column 7 of table 2 indicates by States and groups of States the extent to which forest areas needing protection were covered by some form of systematic protection in the calendar year 1931.[1] The New England, Middle Atlantic, Lake States, north Rocky Mountain, south Rocky Mountain, and Pacific coast regions are shown with already practically complete coverage of all forest areas that need protection. Two important groups, however, are shown to be deficient—the Central group, with 31 percent coverage of forest areas classed as in need of protection, and the South, with only 24 percent.

In these two groups complete coverage will not be secured within 20 years under present forms of organized effort unless the average rate of progress for the country as a whole is brought to bear on these groups specifically. This is particularly true in the South. Such organized protection as has been accomplished in that region has been built up around holdings of owners who have aggressive interest in the protection of their properties. To increase or even to sustain the rate of progress, steadily increased support will have to be provided by the States and the Federal Government. This development will take different forms in different States. The effort to obtain greatly increased public participation must be accompanied by intensive study of the effects of fire in different forest types, by clear-cut definition and exposition of the fundamental benefits to be secured by protection, and by education of private owners and of the local public.

In this connection, however, it should be noted that the 11 States in the Southern region, prior to the advent of Federal cooperation, and even as lately as 1915, had no area under organized protection. For these States to have placed 48 million acres under some form of organized protection within 16 years is a major achievement. The cooperative approach to the protection problem in the South has succeeded admirably in getting the first steps undertaken. The establishment of a satisfactory degree of State-wide protection on the 155 million acres still without it is the task which lies ahead.

PROGRESS IN FINANCING PROTECTION UNDERTAKING

FINANCIAL RECORD IN BRIEF

The curve shown in figure 3 indicates roughly the increase in total funds spent, Federal, State, and private, upon this work from 1911 to 1931. The average annual gain over the 21-year period is $345,670. If this same rate of increase in funds spent upon the work were maintained, the amount of $13,386,273, which was set up by the 1930 estimates already referred to, would be reached in 17 years. The contrasts between expenditures of 1915 and 1931 are shown in detail, in table 2, columns 8 and 9.

---

[1] It is to be noted that the number of acres of State and private forest land needing protection is necessarily a different figure from the total State and private forest area. In many States there are considerable areas of privately-owned forest land that are not classed as in need of organized protection. These are isolated tracts of low fire hazard on individual farms, estates, or properties, the protection of which logically devolves on the resident owners, caretakers, or operators.

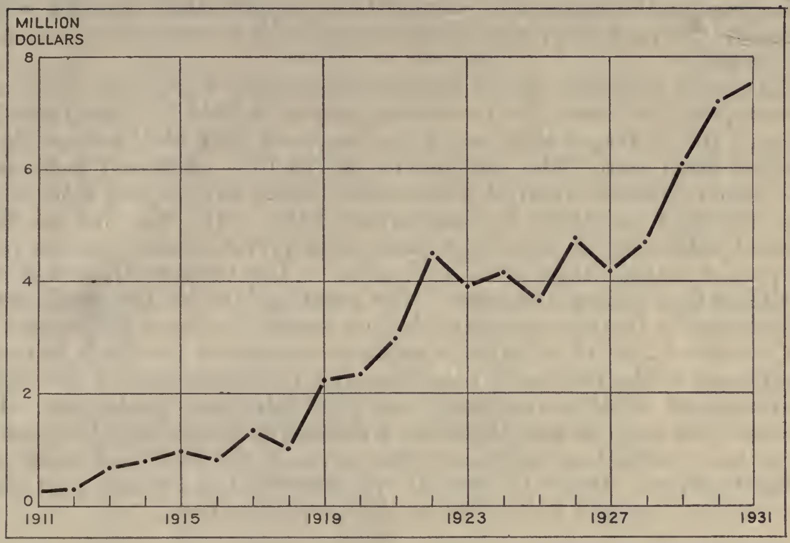

FIGURE 3.—Total annual expenditures (all agencies) in cooperative fire protection of State and privately owned land.

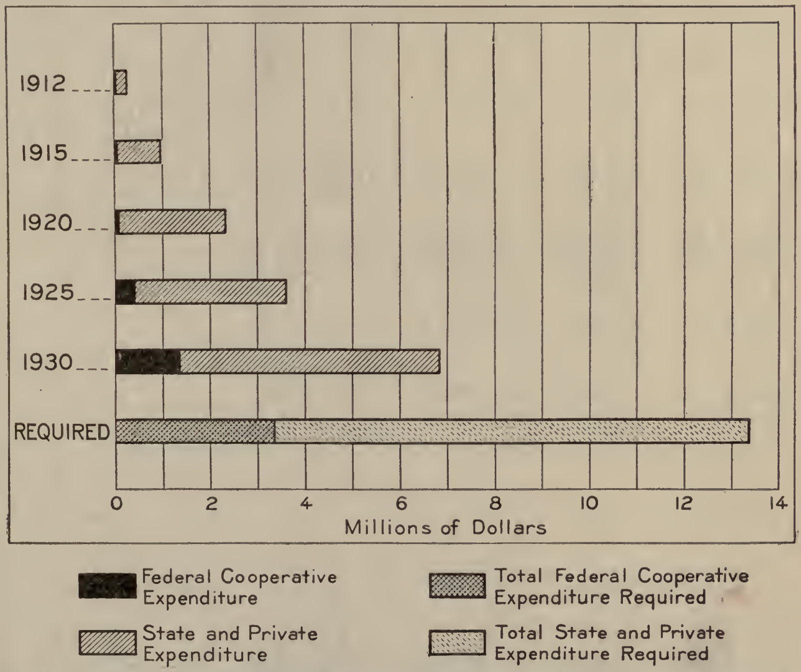

FIGURE 4.—Progress in protection of State and private forest land from fire on basis of expenditure, and estimated expenditure required (1930 estimate) for adequate protection.

Table 3 shows the financial part played by the several cooperating agencies during the fiscal year 1932 by States and groups of States. (To consider the respective shares of the contributing agencies, it is necessary to pass from the calendar-year basis of table 2 to a fiscal-year basis.)

The total expended by all agencies during the fiscal year 1932 on the cooperative forest fire protection project, $5,943,103 (see table 3, column 10), is larger than any previous fiscal year total except that for the fiscal year 1931, which was $6,710,103. Figure 4 indicates the steady upward trend of these expenditures over 5-year intervals. The decrease for 1932, in comparison with 1931, was due to the general difficulty of financing State and private undertakings encountered during that year, and also to the comparative ease of handling fires during the year. The total budget for the fiscal year 1933 shows a further moderate decline under the same influences.

Columns 12 to 16 of table 3 indicate the extent to which the expenditures of the last fiscal year come up to the amounts of the 1930 estimates of what is necessary to give adequate protection. In column 16 it may be seen that only a little over 44 percent of expenditures thus classed as adequate was actually made by all agencies taken together—about 12 percent representing the Federal part and the balance the part of the States and private owners.

TABLE 3.—*Distribution of Federal, State and private expenditures for forest fire protection, fiscal year 1932, and relation to 1930 estimates of adequate expenditures*

Regions and States	Federal		State		Private		Total State and private		Total Federal, State, and private	Estimated cost of adequate protection	Percentage of adequate amount expended by—				
											Federal	State	Private	State and private	All agencies
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)[1]	(12)	(13)	(14)	(15)	(16)
New England:	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Dollars*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Connecticut	14, 008	16. 35	68, 246	79. 63	3, 446	4. 02	71, 692	83. 65	85, 700	76, 000	18. 43	89. 80	4. 53	94. 33	112. 76
Maine	54, 732	24. 39	169, 674	75. 61			169, 674	75. 61	224, 406	342, 000	16. 00	49. 61		49. 61	65. 61
Massachusetts	34, 991	33. 28	70, 154	66. 72			70, 154	66. 72	105, 145	169, 000	20. 71	41. 51		41. 51	62. 22
New Hampshire	18, 012	32. 73	30, 393	55. 22	6, 632	12. 05	37, 025	67. 27	55, 037	131, 000	13. 75	23. 20	5. 06	28. 26	42. 01
Rhode Island	2, 410	22. 28	8, 409	77. 72			8, 409	77. 72	10, 819	17, 000	14. 18	49. 46		49. 46	63. 64
Vermont	7, 894	40. 14	8, 054	40. 96	3, 716	18. 90	11, 770	59. 86	19, 664	57, 000	13. 85	14. 13	6. 52	20. 65	34. 50
Total	132, 047	26. 37	354, 930	70. 88	13, 794	2. 75	368, 724	73. 63	500, 771	792, 000	16. 67	44. 82	1. 74	46. 56	63. 23
Middle Atlantic:															
Delaware	1, 318	9. 90	11, 995	90. 10			11, 995	90. 10	13, 313	12, 000	10. 98	99. 96		99. 96	110. 94
Maryland	12, 203	16. 08	63, 388	83. 51	312	. 41	63, 700	83. 92	75, 903	73, 000	16. 72	86. 83	. 43	87. 26	103. 98
New Jersey	28, 140	17. 29	134, 621	82. 71			134, 621	82. 71	162, 761	128, 000	21. 99	105. 17		105. 17	127. 16
New York	77, 191	21. 38	281, 743	78. 05	2, 050	. 57	283, 793	78. 62	360, 984	378, 000	20. 42	74. 54	. 54	75. 08	95. 50
Pennsylvania	54, 314	12. 74	371, 996	87. 26			371, 996	87. 26	426, 310	364, 000	14. 92	102. 20		102. 20	117. 12
Total	173, 166	16. 66	863, 743	83. 11	2, 362	. 23	866, 105	83. 34	1, 039, 271	955 000	18. 13	90. 44	. 25	90. 69	108. 82
Lake States:															
Michigan	131, 320	20. 05	523, 799	79. 95			523, 799	79. 95	655, 119	662, 000	19. 84	79. 12		79. 12	98. 96
Minnesota	98, 443	20. 44	360, 965	74. 95	22, 216	4. 61	383, 181	79. 56	481, 624	697, 000	14. 12	51. 79	3. 19	54. 98	69. 10
Wisconsin	48, 983	11. 93	361, 597	88. 07			361, 597	88. 07	410, 580	390, 000	12. 56	92. 72		92. 72	105. 28
Total	278, 746	18. 01	1, 246, 361	80. 55	22, 216	1. 44	1, 268, 577	81. 99	1, 547, 323	1, 749, 000	15. 94	71. 26	1. 27	72. 53	88. 47
Central:															
Illinois										77, 000					
Indiana	7, 560	42. 40	10, 271	57. 60			10, 271	57. 60	17, 831	84, 000	9. 00	12. 23		12. 23	21. 23
Kentucky	18, 780	50. 00	18, 780	50. 00			18, 780	50. 00	37, 560	212, 000	8. 86	8. 86		8. 86	17. 72
Missouri										347, 000					
Ohio	7, 491	40. 98	10, 787	59. 02			10, 787	59. 02	18, 278	60, 000	12. 48	17. 98		17. 98	30. 46
Tennessee	25, 320	46. 59	25, 211	46. 39	3, 816	7. 02	29, 027	53. 41	54, 347	245, 000	10. 33	10. 29	1. 56	11. 85	22. 18
West Virginia	31, 348	35. 04	42, 871	47. 92	15, 247	17. 04	58, 118	64. 96	89, 466	312, 000	10. 05	13. 74	4. 89	18. 63	28. 68
Total	90, 499	41. 61	107, 920	49. 62	19, 063	8. 77	126, 983	58. 39	217, 482	1, 337, 000	6. 77	8. 07	1. 43	9. 50	16. 27

---

[1] 1930 estimates.

TABLE 3.—*Distribution of Federal, State and private expenditures for forest fire protection, fiscal year 1932, and relation to 1930 estimates of adequate expenditures*—Continued

Regions and States	Federal		State		Private		Total State and private		Total Federal, State, and private	Estimated cost of adequate protection	Percentage of adequate amount expended by—				
											Federal	State	Private	State and private	All agencies
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11) [1]	(12)	(13)	(14)	(15)	(16)
South:	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Dollars*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Alabama	40, 253	49. 96	9, 172	11. 39	31, 141	38. 65	40, 313	50. 04	80, 566	573, 000	7. 02	1. 60	5. 44	7. 04	14. 06
Arkansas										484, 000					
Florida	65, 826	49. 99	35, 609	27. 05	30, 234	22. 96	65, 843	50. 01	131, 669	847, 000	7. 77	4. 20	3. 57	7. 77	15. 54
Georgia	57, 690	50. 00	22, 712	19. 68	34, 978	30. 32	57, 690	50. 00	115, 380	775, 000	7. 45	2. 93	4. 51	7. 44	14. 89
Louisiana	51, 810	35. 07	62, 711	42. 46	33, 196	22. 47	95, 907	64. 93	147, 717	434, 000	11. 94	14. 45	7. 65	22. 10	34. 04
Mississippi	18, 735	50. 00	17, 296	46. 16	1, 438	3. 84	18, 734	50. 00	37, 469	563, 000	3. 33	3. 07	. 26	3. 33	6. 66
North Carolina	50, 091	50. 00	40, 824	40. 75	9, 266	9. 25	50, 090	50. 00	100, 181	632, 000	7. 93	6. 46	1. 47	7. 93	15. 86
Oklahoma	16, 670	49. 67	15, 890	47. 35	1, 000	2. 98	16, 890	50. 33	33, 560	165, 000	10. 10	9. 63	. 61	10. 24	20. 34
South Carolina	28, 979	45. 58	16, 434	25. 85	18, 168	28. 57	34, 602	54. 42	63, 581	378, 000	7. 67	4. 35	4. 80	9. 15	16. 82
Texas	42, 205	41. 16	46, 496	45. 34	13, 843	13. 50	60, 339	58. 84	102, 544	434, 000	9. 73	10. 71	3. 19	13. 90	23. 63
Virginia	35, 730	40. 62	46, 197	52. 52	6, 039	6. 86	52, 236	59. 38	87, 966	397, 000	9. 00	11. 64	1. 52	13. 16	22. 16
Total	407, 989	45. 30	313, 341	34. 79	179, 303	19. 91	492, 644	54. 70	900, 633	5, 682, 000	7. 18	5. 51	3. 16	8. 67	15. 85
Pacific Coast:															
California	170, 498	25. 01	159, 333	23. 38	351, 731	51. 61	511, 064	74. 99	681, 562	969, 000	17. 60	16. 44	36. 30	52. 74	70. 34
Oregon	104, 092	37. 06	44, 158	15. 72	132, 624	47. 22	176, 782	62. 94	280, 874	584, 000	17. 82	7. 56	22. 71	30. 27	48. 09
Washington	111, 543	37. 71	94, 607	31. 98	89, 645	30. 31	184, 252	62. 29	295, 795	632, 000	17. 65	14. 97	14. 18	29. 15	46. 80
Totals for region	386, 133	30. 69	298, 098	23. 69	574, 000	45. 62	872, 098	69. 31	1, 258, 231	2, 185, 000	17. 67	13. 64	26. 27	39. 91	57. 58
North Rocky Mountain:															
Idaho (North)	64, 041	18. 57	66, 624	19. 32	214, 158	62. 11	280, 782	81. 43	344, 823	420, 000	15. 25	15. 86	50. 99	66. 85	82. 10
Idaho (South)	5, 210	22. 35	8, 145	34. 94	9, 955	42. 71	18, 100	77. 65	23, 310	27, 000	19. 29	30. 17	36. 87	67. 04	86. 33
Montana	30, 145	32. 96	11, 564	12. 64	49, 764	54. 40	61, 328	67. 04	91, 473	190, 000	15. 86	6. 09	26. 19	32. 21	48. 14
Total	99, 396	21. 63	86, 333	18. 78	273, 877	59. 59	360, 210	78. 37	459, 606	637, 000	15. 60	13. 55	43. 00	56. 55	72. 15
South Rocky Mountain															
Nevada	1, 220	17. 38	105	1. 50	5, 695	81. 12	5, 800	82. 62	7, 020	13, 600	8. 97	. 77	41. 88	42. 65	51. 62
New Mexico	2, 042	24. 20	2, 762	32. 74	3, 633	43. 06	6, 395	75. 80	8, 437	26, 000	7. 86	10. 62	13. 97	24. 59	32. 45
South Dakota	1, 125	48. 10	1, 214	51. 90			1, 214	51. 90	2, 339	4, 500	25. 00	26. 98		26. 98	51. 98
Total	4, 387	24. 65	4, 081	22. 93	9, 328	52. 42	13, 409	75. 35	17, 796	44, 100	9. 95	9. 25	21. 15	30. 40	40. 35
Hawaii	466	23. 42	1, 524	76. 58			1, 524	76. 58	1, 990	5, 173	9. 01	29. 46		29. 46	38. 47
Grand total	1, 572, 829	26. 46	3, 276, 331	55. 13	1, 093, 943	18. 41	4, 370, 274	73. 54	5, 943, 103	13, 386, 273	11. 75	24. 48	8. 17	32. 65	44. 40

---

[1] 1930 estimates.

The theory underlying the operation of the Clarke-McNary Act is that the Federal Government should furnish some 25 percent of the cooperative funds utilized. In terms of the amount which is estimated as necessary to give adequate protection, it is seen that in 1932 the Federal Government underwrote 47 percent of its maximum estimated obligation (one quarter of the total) and the States and private owners 44 percent of their three quarters.

An inspection of the record by regions, however, reveals striking inequalities. First, with reference to the performances of all agencies taken together, we find that in 1932 the Middle Atlantic group of States has already substantially exceeded its share of expenditures estimated as necessary, the percentage given being about 109. Next in order come the Lake States, whose actual expenditure is 88 percent of that needed. For the northern Rocky Mountain region the figure is 72. For New England it is 63, but there the fire season was very favorable, and something less than 100 percent would here have been expected in any event. The South and Central States each show the strikingly low figure of 16 percent. In the South it is to be noted from column 12 that the figure representing the Federal expenditures is 7 percent of the amount needed from all agencies, or, as shown in column 3, approximately 45 percent of the entire actual expenditures for the year. For the Central States there is a similar correspondence between the low percentage for all agencies (column 16) and the high percentage, approximately 42 percent, for the Federal share (column 3). This large sharing by the Federal Government follows from the Federal policy of guaranteeing a minimum allotment to any State which can qualify, the minimum being a certain percent (8 percent for 1933) of the estimated amount needed for adequate protection.

Reference has already been made to the difference between the 1930 estimate of annual cost for adequate protection ($13,386,273), and the larger estimate arrived at in the section covering Protection Against Fire. The 1930 estimates were made for each State separately and in cooperation with the individual State forestry departments. They attempted to give the costs of organization and improvement programs necessary to afford adequate protection on the basis of existing conditions. The basic figures for this series of estimates are revised at approximately 5-year intervals, so as to take account of changing conditions and new information applicable to problems of the individual States. Figures for the larger estimate were arrived at by a careful adaptation of actual costs upon national forests and upon standards of protection set up for each major forest type. They were calculated by regions and not by States.

SHARING THE COST OF PROTECTION BETWEEN PRIVATE OWNERS AND THE PUBLIC

When the Clarke-McNary law was passed, the theory was held that the cost would ultimately be divided at least roughly as follows: Private owners, 50 percent; States, 25 percent; Federal Government 25 percent.

In table 3, columns 7, 5, and 3, we find that the actual percentages for 1932 over the country as a whole were: Private owners, 18.4 percent; States, 55.1 percent; and Federal Government, 26.5 percent. The position of the private owners and the States thus represents a complete reversal and more, of the theoretical relationship. Furthermore, the tendency is to draw still further away from dependence on private money toward a more nearly complete dependence on public money. The proportionate sharing varies greatly in different regions. Fire protection in the New England, the Middle Atlantic, the Lake States and, to a less degree, the Central regions already is very nearly upon a basis of complete public support, the private expenditures of 1932 being 2.75, 0.21, 1.44, and 8.77 percent, respectively. The Pacific coast and the two Rocky Mountain regions, taken together, are approximately upon the theoretically accepted basis of 25 percent Federal, 25 percent State, and 50 percent private support, while the South approaches equal sharing by the Federal Government on the one hand and the State and private owners on the other.

In the northwestern section as a whole, fire protection was started in merchantable stands of timber, and the private owner took the initiative. Originally he could afford to pay the whole bill and was willing to do so. As he removes his merchantable values, however, his interest diminishes, and when the first major operation is completed he is often not disposed to hold and protect his cut-over areas. This later situation is at present acute only in one State, but it is anticipated in others. The difficulties are augmented by the fact that the cost of protecting cut-over land is much greater than for protecting mature stands, the ratio being sometimes as great as 10 to 1. In certain cases continuous yield or selective cutting management will cause the owner to retain his interest, but as a rule the assumption by the public of an increasing share of expense becomes definitely necessary as cutting proceeds. In the important Pacific coast and North Rocky Mountain regions the large sharing of costs by the private owners in 1932 does not, in itself, promise stability in protection. In certain parts of these regions the reverse is true for the reason explained. In the Northeast and in the Lake States the adjustments have already been made, and the public has assumed the bulk of the protection costs.

In the South we have almost the opposite condition to that in the Northwest. Protection interest here centers in second-growth timber and in reproduction. The short-rotation for turpentine, in particular has moved certain large onwers to initiate protection with the help of the States and the Federal Government. The private interest and support seems likely to continue and to increase, although not to such a degree as to promise anything like State-wide protection. For State-wide results, the public funds, and especially State funds, will have to be greatly increased, and this may be a slow and laborious process. The cooperative plan has, however, succeeded admirably in the South in getting some degree of systematic protection started where there was none.

Figure 5 is a graphic summary, by regions, of the financial status of forest fire protection by the public and private agencies. The actual expenditures are shown in dark shading and the additional amounts needed to give adequate protection in light. In calculating the additional amounts, 25 percent of the total sum needed was taken as the ultimate Federal share and 75 percent as that of the States and private owners.

RECORD OF FOREST FIRES

Table 4 presents regional data from which an idea can be obtained as to the effectiveness of recent fire protection work. The figures are averages for the 5-year period 1926–30, and apply to protected areas only. Column 6 shows the proportion of area burned annually relative to the area protected; column 7, the proportion of allowable annual burn to area protected; column 8, the number of acres in the average fire on protected land. The "allowable burn" is defined as the area that may burn over annually without impairing radically the forest values, if the predominant purposes of forest management in a given type are to be attained. This practical standard of fire control is more fully treated in the section entitled "Protection Against Fire." It must be noted that in tables 2, 3, and 5 of that section unprotected areas are included, while they are excluded from the present case.

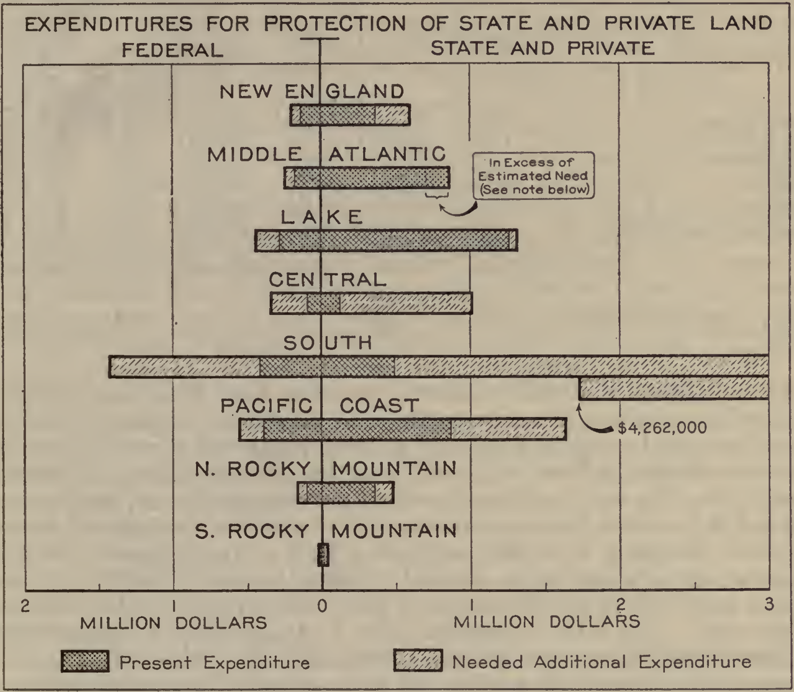

FIGURE 5.—Present expenditure (F.Y. 1932) for protecting State and private land from forest fire, in contrast with total expenditures needed (1930 estimates), show that the pressing need for increased appropriations is centered in the South and Central regions. Note: In the Middle Atlantic region the State and private owners spent more in F.Y. 1932 than the estimated requirement. Average expenditures for 5 years past would fall somewhat below this requirement.

TABLE 4.—*Area burned on protected area, State and private land—Yearly average, 1926–30*

Region	Number of fires per year	Area burned yearly					Size of average fire
		Productive forest [1]	Nonproductive forest [2]	Total	Percentage of protected areas		
					Actual burn	Allowable burn	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Acres	*Acres*	*Acres*	*Percent*	*Percent*	*Acres*
New England	3, 643	74, 938	20, 936	95, 894	0. 31	0. 16	26. 3
Middle Atlantic	6, 590	270, 983	56, 822	327, 805	1. 08	. 35	49. 7
Lake States	4, 918	318, 664	238, 602	557, 266	1. 08	. 36	113. 3
Central	2, 868	272, 304	3, 098	275, 402	1. 80	. 59	96. 0
South	15, 893	1, 627, 215	68, 302	1, 695, 517	3. 30	1. 34	106. 7
Pacific coast	4, 964	456, 320	498, 785	955, 105	2. 41	. 49	192. 4
Northen Rocky Mountain	1, 166	91, 740	16, 982	108, 722	. 87	1. 05	93. 2
South Rocky Mountain	149	2, 134	2, 834	4, 968	. 11	. 41	33. 3
Total	40, 191	3, 114, 298	906, 361	4, 020, 659	1. 70	. 88	100. 0

[1] Includes mature merchantable timber and young timber.

[2] Includes protection areas whether forest or nonforest and areas of no watershed protection, or forest values.

From column 6 it will be noted that the New England, northern Rocky Mountain, and southern Rocky Mountain groups are the only ones showing less than 1 percent of area protected which is burned. Further, the north Rocky Mountain and the south Rocky Mountain groups are the only groups in which the percentage of actual area burned is less than the percentage of allowable burn as defined above. In New England it is indicated that fires covered about twice as great an area as should be allowed under adequate protection. These States spent, in 1932, 63 percent of the 1930 estimate of the adequate allowance. (See table 3, column 16.) In the Middle Atlantic States the area burned was about three times that allowable, while the 1932 expenditures were 109 percent of the estimated adequate amount. In the Lake States the area burned was again about three times that allowable, and the 1932 expenditures were 88 percent of the adequate estimate. In the Central States the area burned was about three times, in the South between two and three times, and in the Pacific coast region approximately five times the theoretically allowable burn.

For the entire country the area burned over each year from 1926 to 1930 within protected areas was 1.70 percent of those areas, whereas the allowable burn was 0.88 percent. In other words, the area burned was almost exactly twice what it is calculated should be permitted to insure the production of full forest values on these lands.

AVERAGE SIZE OF FIRE

A study of the figures by years from which the averages of column 8 of table 4 are made up shows that, over the country as a whole, there was a decrease in the number of acres burned per fire, from 135.7 acres in 1926 to 86.8 in 1930. In the New England, Middle Atlantic, and South regions, this trend toward smaller area burned per fire is striking and evidences substantical progress. It is also to be noted in many individual States of the other regions. The effect of the relative severity of the season upon the size of the average fire is, however, most compelling. It is so important, in fact, that a true index of protection efficiency must await a much longer statistical period than that now available.

NUMBER OF FIRES

The annual record for the years 1926–30 shows a steady increase in number of fires and, despite the decrease in acreage per fire, an increase in total area burned annually on the protected areas. While some of this increase naturally follows from the fact that the area protected was also increasing, it is significant to note that whereas the area protected increased 29 percent during the 5 years, the number of fires increased 124 percent and the area burned 43 percent.

The increase in number of fires is perhaps further explained by the fact that, with the better protection which certainly was provided in 1930, the record itself was more complete. This same phenomenon, however, is observed on the national forests and in States where a fairly uniform standard was maintained during the 5-year period. The real causes must be sought in a number of factors, some of which are climatic, as for example, decreased precipitation. In some sections a resistance on the part of local users of land to the development of young forest growth and "rough" has led to incendiarism. Very important, also, is the fact that people are traveling over the highways and using the woods in increasing numbers.

It is noteworthy that in one particularly bad fire section of New England where an intensive educational campaign in fire prevention was carried on over a 3-year period, the records show an increase and not a decrease in number of fires. Nevertheless, by intensive patrol and well organized suppression, the net result was a striking decrease in area burned as well as in the total protection costs. The local public was mobilized in this protection effort in a most thorough manner. The inference is clear that the gain was due to prompt detection of fire and aggressive attack, not to any real improvement in the matter of prevention of fire occurrence.

There is no doubt that forest-fire occurrence in the United States is rather generally on the increase, whatever may be the causes. This cannot be taken to mean that our protection efforts are decreasing in efficiency. We know that the reverse is true. It means that much greater effort is demanded if adequate control is to be obtained.

AREAS BURNED ON UNPROTECTED AREAS

The fire record for the more than 190 million acres classed as in need of protection and receiving none is exceedingly inaccurate. A great deal of work is done, however, to get rough estimates of forest or potential forest area burned within this "no man's land." Table 5 shows the yearly averages for the period 1926–30 of areas burned on unprotected areas, as nearly as the data allow, together with areas burned on protected areas, repeated for comparison. It will be noted at once that the great bulk of the total area of State and private land which is burned in all States (37 million out of 41 million) is within the unprotected area. The relative effectiveness of our protection effort, despite all drawbacks, is witnessed by the fact that whereas 1.7 percent of the protected area was burned, fires are reported to have covered 19.76 percent of the unprotected area in an average year of the period covered. These points are illustrated in figure 6.

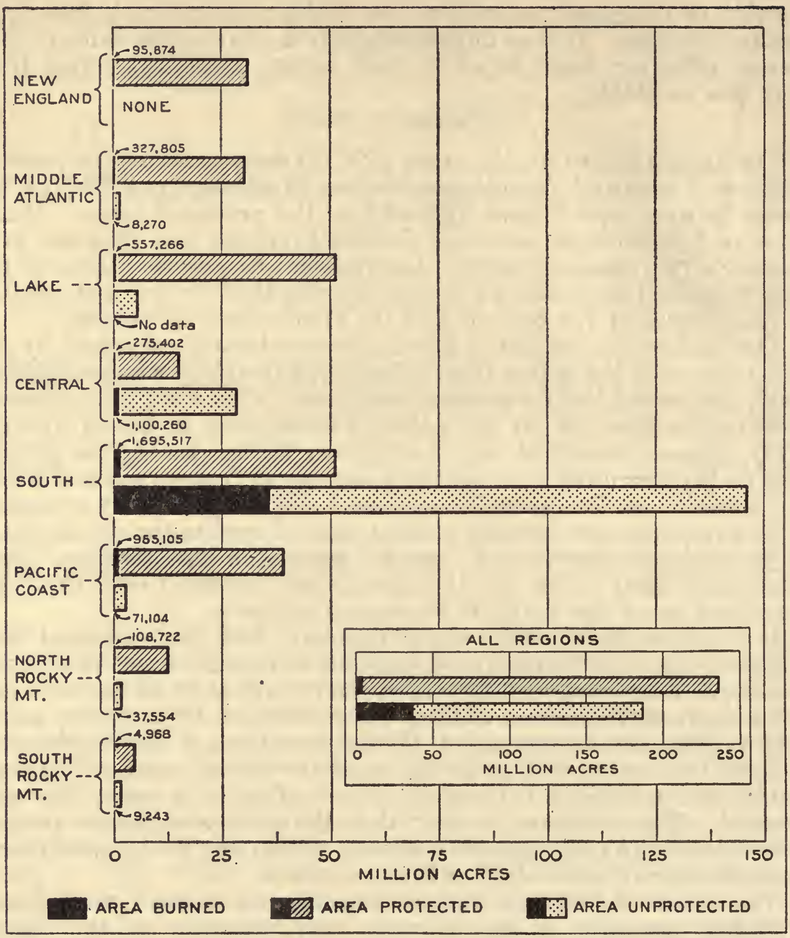

FIGURE 6.—Areas burned yearly on State and private lands protected and unprotected from fire, 1926–30.

TABLE 5.—*Area burned on protected and unprotected areas—Yearly average, 1926–30*

Region	Area burned			Percent protected	Percent unprotected	Percent total	Ratio to allowable burn [1]
	On protected lands	On unprotected lands	Total				
	Acres	*Acres*	*Acres*				*Percent*
New England	95, 874		95, 874	0. 31		0. 31	194
Middle Atlantic	327, 805	8, 270	336, 075	1. 08	. 51	1. 04	297
Lake States	557, 266	(2)	557, 266	1. 08	(2)	(2)	(2)
Central	275, 402	1, 100, 260	1, 375, 662	1. 80	3. 89	3. 16	536
South	1, 695, 517	35, 844, 767	37, 540, 284	3. 30	24. 52	19. 01	1, 419
Pacific coast	955, 105	71, 104	1, 026, 209	2. 41	2. 58	2. 43	496
North Rocky Mountain	108, 722	37, 554	146, 276	. 87	2. 39	1. 04	99
South Rocky Mountain	4, 968	9, 243	14, 211	. 11	. 63	. 23	56
Total	4, 020, 659	37, 071, 198	41, 091, 857	1. 70	19. 76	9. 68	1, 100

[1] Protected and unprotected.
[2] Certain areas in Wisconsin and Minnesota were reported as unprotected, but data as to fires on these areas are lacking.

Forest fires on unprotected areas are mainly a problem of the South and Central regions, and actually 97 percent of the unprotected areas burned were in the South. In two States of this region, a special effort has been made to determine acres burned in unprotected areas. In one of these States 20 percent of the unprotected area was estimated as having been burned over in 1931, as against 3⅓ percent of the protected area. The corresponding figures for the other State were 14.6 percent and 3½ percent. In a third State an 8 percent burn on protected units in 1931 is contrasted by the State forester with a 50 percent estimate of burn on areas that are unprotected. It must, of course, be borne in mind that fires do less relative damage in the pine woods of the South, where the bulk of unprotected area lies, than in many other regions.

The last column of table 5 indicates, for protected and unprotected areas together, the standard of fire control attained to date. From the total of this column it appears that, for the country as a whole, we are burning more than 11 times as many acres of State and private land as we should if standard forest growing conditions are to be maintained, the ratio of actual to allowable burn being 1,100 percent.

SIGNIFICANCE OF FEDERAL COOPERATION BY REGIONS

NEW ENGLAND

In the New England region, Federal funds have not been needed to initiate or insure State forest-fire protection activity. If these funds were discontinued, however, their complete replacement by the States might, according to the regional inspector, take as long as 10 years. In Maine, effective participation by the State in the protection of about 5 million acres of forest land outside a defined forestry district has been undertaken largely as the result of Federal cooperation.

There is no doubt that protection standards have been raised in the Northeast as elsewhere on account of Federal cooperation, although the States would have functioned fairly satisfactorily without Federal participation.

MIDDLE ATLANTIC

The situation in the Middle Atlantic region is similar to that in New England. A good standard of protection would be maintained in most of these States with or without Federal aid. Federal money of course contribute to the efficiency of the work, and during seasons of maximum difficulty it is of vital importance in sustaining the State's efforts. There has been mutual gain through contact with Forest Service personnel and, through this medium, with the work going forward in other States and regions and on the national forests. In one State, the initiation of State forestry activities was very directly contingent upon assistance by the Federal Government.

In another, Federal cooperation can be credited with the initial extension of protection and with current supervision of protection on an area of about 8 million acres of cut-over lands.

In other States of this region and throughout the country, Federal aid has undoubtedly contributed to the financial ability of States to employ trained forestry personnel and to raise the standards of organization and service, which in turn has been directly reflected in more adequate protection of forest areas.

LAKE STATES

In the Lake States region a significant contribution of the Federal Government has been assistance in building effective organization and in coordination of the activities of adjoining States through the field work of the Federal inspectors. Outstanding fire divisions have been developed in each of the departments of conservation of Michigan, Wisconsin, and Minnesota, partly through Federal cooperation. Until recently the Federal funds, in themselves small in proportion to State funds, have perhaps been of less significance than the contribution to plans and policies, but in at least one of these States the Federal financial aid has resulted in substantially increased areas under systematic protection.

CENTRAL

The Central region includes Tennessee and Kentucky, which are generally classed as Southern States and to which may be applied the statements made for the South under the next heading. In the other Central States as a group, Federal aid has been a developing influence of large importance. In two States of this region cooperation has been discontinued pending the revision of State programs.

SOUTH

In the South the feature of Federal cooperation of perhaps greatest significance is its stimulating effect upon organization for the protection of forests from fire. All the States in this group have begun or strengthened their protection work under the stimulus of available Federal aid and with the help of Forest Service officers called into consultation by State legislatures and civic groups. In five of the States, the actual establishment of State forestry departments was quite directly due to the availability of Federal funds to help in carrying out forestry programs. In this region is found nearly half of the total State and private forest area in the country which is classed as needing public protection, more than 200 million acres, of which 150 million acres or more is still unprotected. It is a region where the forest is of great commercial importance and rapid growth and where its protection and development have, thus far, received inadequate public consideration.

It is important to recall that efforts toward organized protection of forest land in the South have been made only during the past few years. In only 5 of the 11 States in the South was this work undertaken as a State activity prior to 1925. Protection is here still in the pioneer stage. Those in a position to effect State action probably do not yet visualize the needs of forestry in true perspective in relation to such other public enterprises as schools and roads. The needs and the means of forest protection are now being actively presented, and support of the work is steadily gaining.

One of the greatest needs is the determination of forest and fire facts and their proper presentation. Experience has proved that protection cannot be suddenly organized and made effective over large areas until the landowners themselves want their lands protected and are ready to pay for part of it either directly or out of funds raised by taxation. It can be successful only under enthusiastic local cooperation.

There is amply reason to be encouraged over results thus far accomplished, and the cooperative system embodied in the Clarke-McNary law is here particularly well adapted to the great variety of conditions encountered.

PACIFIC COAST

Federal cooperation in fire protection in the Pacific coast region has meant better protection than would have been practicable without it. It has meant increased funds from the States and from private owners. It has tended to sustain the interest of owners in their deforested land and to make the financing of far-reaching programs appear practicable. It has considerably advanced legislation and plans. To make these gains secure by some guarantee of continuity in the protection thus far attained is the purpose to which the Forest Service is bending its energies.

In California there has been a marked increase in State and county funds in recent years, as from $73,000 in 1921 to $505,000 in 1931. This was accompanied by an increase in Federal funds from $23,000 to $148,000. The State forestry department has been rapidly expanded and the work greatly increased. Federal cooperation has here been a strong stimulus and also has helped greatly through participation in plans and in making available the experience on the national forests. The financial help and moral support of the Federal Government has been effective in sustaining the State's efforts in protecting large areas which may later come into public ownership. Meanwhile, the public has a special stake in safeguarding its investment by the continuance of this work.

The region is characterized by a real need for an appreciation of Federal cooperation. Even though local financial support of the work is comparatively large, the part played by Federal cooperation is vital.

NORTH ROCKY MOUNTAIN

Federal cooperation in the north Rocky Mountain region had an important influence upon the passage of advanced pieces of forestry legislation, including provisions for compulsory participation in the protection of their forest properties and slash disposal by the private owners.

Federal cooperation has increased the numerical strength of the protective organizations and has improved performance, especially through close contact of associations and national forest officers. Improved practice has resulted from contact with activities on the national forests. The lumber industry has gained a better understanding of the aims and objects of forestry and has recognized the practicability of some of its phases to its own problem.

Federal aid has not prevented the breaking down of protection on about 150,000 acres in one instance in Idaho. The question naturally arises, Could the Federal cooperation have been so handled as to have prevented this? Possibly this cooperation came too late, or the funds were insufficient. In 1932 the State contribution, 19 percent of the total, was entirely for the protection of State land. Federal expenditures constituted 19 percent of the total and applied in part to State land. The public thus shared less than 19 percent of the cost of protecting privately owned land in that State. The agricultural southern counties, with predominating legislative representation, would no doubt effectively check large undertakings by the State which would appear to benefit only timberland owners in the north. Even so, the State biennial appropriation increased from $80,000, in 1924, the year previous to Clarke-McNary appropriations, to $150,000 in 1932.

Although the problem for the future appears to be too great for the forest protective machinery thus far set up, it is true that protection has been greatly advanced by Federal cooperation in this region. The protection system here may in some cases be a temporary expedient, but even if so, it is a very important one.

It is to be hoped that the experience of many countries and of other States may not need to be suffered in this "Inland Empire" region—the cutting out and abandoning of the forest. Already the public is protecting its interest much more than did such regions as New England and the Lake States during the corresponding periods in their forest history. This is a hopeful sign. The picture of other States now spending millions to bring back the departed glories of the forest is no doubt exerting its influence upon the Northwest today. It is the writer's opinion that the northwestern regions will keep their cut-over lands under protection and that Federal cooperation will be an important factor in this accomplishment.

SOUTH ROCKY MOUNTAIN

In only three States of the South Rocky Mountain region has forest fire protective cooperation been undertaken, namely, in Nevada, New Mexico, and South Dakota. In New Mexico the private owners and the State contract the work to the Federal Government. Federal aid has resulted in a listing of State land with the Forest Service for protection and in the initiation of protection on some private lands and its retention on others. In Nevada a somewhat similar result has been secured. Without Federal cooperation here the protection effort of private owners would be of much less effect. In South Dakota, Federal cooperation has resulted in legislation enabling the State to protect 124,000 acres of forest land, mostly privately owned.

The area of forest land which is outside the national forests in other States of this region is not great enough to have given rise to cooperative State projects up to the present.

SUMMARY OF RESULTS IN FEDERAL AID IN FOREST FIRE PROTECTION

1. Federal cooperation has been an important factor in the establishment of 12 State forestry departments. In 17 States the protection of private forest land was commenced as a State activity as the direct result of Federal cooperation.

2. Under Federal cooperation the area of State and private forest land receiving organized protection increased from 95 million acres in 1915 to 228 million acres in 1931. Should this same rate of increase

be continued, the entire area needing protection would be covered in about 20 years. During the same period Federal, State, and private funds devoted to forest fire protection have increased from $984,000 to $7,222,000. Federal aid has been an important factor in this increase in area protected and in funds provided. The results are much more important than would be represented by the area which could be directly protected each year by a sum equivalent to the Federal aid appropriated. It should be noted that in the fiscal year 1932 the Federal Government financed 47 percent of its assumed obligation for an "adequate" program of protection, and the States and private owners 43 percent of theirs.

3. Forty-six per cent of the State and private forest land classed as in need of protection is still unprotected. This area lies for the most part in the South and Central regions, where Federal aid has meant the most in getting protection started.

4. On protected areas forest fires have annually burned over 1.7 per cent of the area protected, whereas fires have covered about 19.8 percent of unprotected areas. This proves that the protection work undertaken has caused a sharp reduction in fire damage.

5. Forest fire protection in the New England, Middle Atlantic, Lake, north Rocky Mountain, south Rocky Mountain, and Pacific coast regions is well established. In many areas it can be expected to develop adequately under present plans, with increase in public support which can be anticipated. In parts of the north Rocky Mountain and Pacific coast regions, however, conditions are developing that may become critical as a result of the tendency toward abandonment of protection by owners interested primarily in the merchantable timber now on the land. The need here for a larger sharing in protection costs by the Federal Government and the States is clearly indicated. Fortunately, the area involved is comparatively small (less than 4 per cent of forest area of the country), although the present importance of the timber is very great.

In the South lies the great unprotected forest area, and to apply the proper degree of protection involves difficult problems which have important social as well as economic and financial aspects. Progress will, it is believed, be necessarily slow. The private owner here has an increasing interest, since the forest land principally involved is coming up to stands of rapid-growth timber which are being commercially utilized at a young age. This interest cannot, however, be relied upon to bring State-wide protection without increased public participation.

6. In the administration of Federal aid the Forest Service has served as a clearing house for information and for educational material to the advantage of the State projects. The merit system in the employment of men has been promoted, technical standards among personnel have been raised, and methods of protection have been measurably improved.

7. The questions may be asked, Has Federal aid in fire protection stimulated the practice of forestry on private land? To what extent is such Federal aid effective in keeping lands in private ownership?

In most cases where the question is up for decision whether an owner shall retain title to a piece of forest land or let it go tax delinquent, the answer is based upon many considerations other than protection. Insofar as the protection consideration has force, Federal aid has had a stabilizing influence through the increased forest values which have resulted. Federal aid has promoted protection, but the whole of protection is only one element, though a very necessary element, in the development of the forests for use under private ownership.

During the transition period between that in which the main supply of timber comes from old growth and that in which it will come from regrown timber on lands previously cut over, the practice of forestry by the private owner will, it is believed, slowly but steadily increase. There may be many set-backs. The final classification of lands which should be devoted to forest uses has not yet been made. But fire protection remains the necessary condition in the absence of which the practicability of forestry can hardly be intelligently determined. Moreover, fire protection is of distinct social and economic advantage, whether or not it is now leading owners to planned and intensive forest management.

In the case of second-growth stands as contrasted with old-growth stands, the significance of protection, even in the absence of conscious silvicultural management, is relatively great, and it is with the protection of second-growth stands that the public is principally concerned. When second growth comes into yield, the operator seldom makes a clean sweep of the stand. As compared with logging in the virgin forest, operations are on a smaller scale, leaving more chance for natural restocking. Cutting a smaller proportion of the trees frequently presents to the owner the natural means of securing quick returns. Self-interest of such an owner leads him into some form of selective logging, and the result is less devastation over large areas. This means that second-growth stands can be made continuously productive under protection alone to a much greater extent than may be generally supposed.

FEDERAL AID IN FARM FOREST PLANTING

Prior to 1925 there was an active demand for forest planting stock in many States in excess of the supply. Only 18 States were distributing trees for forest planting. Farmers own about 127 million acres of forest land, much of which can be greatly improved by planting. They own much land which has been abandoned for agricultural crops, but which can be profitably utilized if planted to trees. Such a venture is possible to the farmer only if he can secure the right trees of the right size, in quantity, at low cost. He could not find such opportunities in the open market.

Section 4 of the Clarke-McNary Act provided for the first time for Federal cooperation with the States in the production and distribution of trees for farm planting. In the words of the law, the Secretary of Agriculture is authorized and directed

> To cooperate with the various States in the procurement, production, and distribution of forest-tree seeds and plants, for the purpose of establishing windbreaks, shelter belts, and farm woodlots upon denuded or nonforested lands within such cooperating States, under such conditions and requirements as he may prescribe to the end that forest-tree seeds or plants so procured, produced, or distributed shall be used effectively for planting denuded or nonforested lands in the cooperating States and growing timber thereon: * * *.

This section includes the usual limitation of Federal expenditures to amounts not exceeding those expended by the State for the same purpose. The authorization of the amount to be appropriated annually is limited to not more than $100,000.

This provision became effective through the appropriation of $50,000 by the Federal Government on July 1, 1925. For the fiscal year 1932, the appropriation was $95,000, while that for 1933 is $79,960. For the 7-year period 1926–32 the Federal expenditures have totalled $530,487. Table 6 shows the distribution of expenditures as between the States and the Federal Government during that period.

ADMINISTRATION

The projects are managed by the States, just as in the administration of cooperative forest fire protection, and the Federal inspector participates in State plans and budgets. He inspects the work to determine the effectiveness with which moneys are spent. Upon his certification the States are reimbursed by the Federal Government to the extent of its obligation after the initial payments are made by the State.

RESULTS

In 1926, in direct response to the stimulus of Federal aid, the number of States raising and distributing trees for planting increased from 18 to 30. Forty States, including Puerto Rico and Hawaii, are engaged in this activity during the present fiscal year (1933), 18 of which owe their start in the work to the provision of Federal assistance.

During the 6 calendar years 1926–31, under the Federal cooperative projects, a total of 156 million trees were distributed to farmers by the States. From this it would appear that something more than 150,000 acres of farm woodlands and shelter belts were newly established. Many of the plantings have served as demonstrations to guide neighboring farmers. During the same period the cooperating States reported the distribution, without aid from the Federal Government, of 113 million trees to private landowners other than farmers and the planting of 150 million trees on State forests.

TABLE 6.—*Expenditures in aid of farm forest planting*

Year	Federal	State	Total
1926	$45, 006	$223, 272	$268, 278
1927	71, 195	241, 738	312, 933
1928	74, 977	301, 664	376, 641
1929	74, 372	295, 245	369, 617
1930	80, 479	322, 035	402, 514
1931	90, 798	248, 091	338, 889
1932	93, 660	204, 438	298, 098
Total	530, 487	1, 836, 483	2, 366, 970

Only a small increase has occurred from year to year in farm planting over the country as a whole. Starting in the calendar year 1926 with about 23 million trees planted, the number increased to 29 million in 1928, but during the next 3 years it dropped to an average of about 25½ million.

Generally speaking, the projects have not developed into quantity production on a large scale but have held to an average distribution of less than a million trees for farmers per year per State, their effect being primarily educational and demonstrational. Considerably more trees would probably have been distributed during the past 2 years except for the depression. The general course of farm planting is indicated in table 7.

This table shows substantial increases in all regions except in the New England and the Middle Atlantic regions. The sharp declines in these regions were sufficient to cause a net decline for the country as a whole since 1928. It should be noted, however, that both these regions have substantially increased distribution to private landowners other than farmers and planting on their State forests, so that their grand total, including distribution outside the Clarke-McNary law cooperation, shows an increase—New England from 7 million in 1926 to 8¾ million in 1930, and the Middle Atlantic region from 32 to 36 million. The distribution of trees which the cooperating States made in 1930 for all uses is shown, by regions, in table 8.

TABLE 7.—*Number of trees distributed to farmers*

Region	Year		
	1926	1928	1930
New England	2, 790, 000	3, 003, 000	2, 262, 000
Middle Atlantic	17, 385, 000	19, 897, 000	13, 481, 000
Lake	580, 000	1, 335, 000	2, 029, 000
Central	1, 206, 000	2, 779, 000	3, 540, 000
South	119, 000	549, 000	1, 874, 000
Pacific coast	5, 000	126, 000	263, 000
North Rocky Mountain	83, 000	227, 000	433, 000
South Rocky Mountain	71, 000	202, 000	239, 000
Hawaii and Puerto Rico	371, 000	639, 000	1, 715, 000
Total	22, 610, 000	28, 757, 000	25, 836, 000

REGIONAL ASPECTS OF FEDERAL COOPERATION IN FARM PLANTING

In New England forest tree nursery practice was already developed by most of the States prior to the time of Federal participation. Federal cooperation has, however, resulted in some reduction in the price which the farmer has had to pay for the trees and has led to more effective inspection of plantations to check up on and to insure success in planting. It has also led to more thorough accounting by the States for all planting activity.

In the Middle Atlantic region we find much the same situation as in New England. Most of the States were active in planting before Federal participation, but one or possibly two of the States would not have initiated tree production and distribution without Federal help.

In the South, forest nurseries would probably not have been attempted by at least six of the States without Federal cooperation. Here advice and assistance other than financial in establishing the nurseries has also been of distinct advantage. From the point of view of education and demonstration, the State forestry departments are making good use of tree poduction and distribution as one of the important means of furthering the practice of forestry.

TABLE 8.—*Distribution of forest planting stock, by regions, for the calendar year 1930*

Region	Number of trees distributed			
	To farm lands (Clarke-McNary projects)	To State lands	To privately owned lands other than farms	Total
New England	2, 261, 601	3, 127, 500	3, 323, 786	8, 712, 887
Middle Atlantic	13, 480, 735	8, 683, 550	14, 273, 750	36, 438, 035
Lake States	2, 028, 709	17, 558, 500	2, 369, 150	21, 956, 359
Central	3, 540, 455	588, 375	966, 850	5, 095, 680
South	1, 873, 980	75, 429	1, 502, 924	3, 452, 333
Pacific coast	262, 631	------------	------------	262, 631
North Rocky Mountain	433, 400	------------	15, 900	449, 300
South Rocky Mountain	239, 304	12, 900	11, 500	263, 704
Hawaii	158, 400	365, 700	390, 700	914, 800
Puerto Rico	1, 557, 000	31, 700	185, 200	1, 773, 900
Total	25, 836, 215	30, 443, 654	23, 039, 760	79, 319, 629

In States or parts of States where tree growth is largely absent, typified by parts of Montana, Wyoming, Colorado, the Dakotas, and Nebraska, farm planting is mostly in the form of windbreaks and shelter belts. A block of trees set so as to protect farm buildings and stock or cultivated fields and orchards is here of high importance. Federal cooperation has been definitely helpful in establishing such plantations. In 1931 in the States of Montana, Idaho, North Dakota, Iowa, Nebraska, Colorado, Wyoming, and Utah, approximately 3,000 farmers established such plantations. Their value to farm homes and as demonstrations is inestimable. The work would probably not have been undertaken in at least five of these States without the impetus of Federal aid.

In other States, as in Tennessee and Mississippi, the planting of gullied portions of farms is returning otherwise waste areas to profitable use.

DIFFICULTIES ARISING FROM FARM LIMITATION

Three fourths of the State nurseries are raising stock for reforestation of other land than farm land. Under the law, however, the Federal Government can cooperate with these States only in that part of their work which involves the production and distribution of trees to farmers. The line is difficult to draw, and the distinction seems illogical. The point of view of the State foresters is that the needs of the land rather than the classification of the owner is of first importance, although the large owner who may need no public help would not generally be served until small applicants had been satisfied. An amendment to change the conditions of Federal cooperation in this respect has several times been presented to Congress.

CONCLUSIONS

Federal aid in farm forest planting has been directly responsible for the initiation of such work as a State activity in at least 18 States; this is its greatest achievement. It supplied to each State a small sum, about $2,000, with which the State was enabled to find $2,000 additional to start the work.

The effect of the Federal contribution has been to reduce the price of trees which the farmer has to pay. It appears to be desirable to sell the trees rather than to give them away. They are more highly valued and better planted when obtained only for a price. This price is low. In theory it is less than cost by at least the amount of the Federal appropriation, because, under the Federal regulations made in the administration of the project, the State is not permitted to recover through sale an amount in excess of what the State itself puts into the work. In most States the recovery is much less than that.

Federal cooperation has tended to improve State practice. In lieu of money it has supplied Norway pine seed when hard to get from other sources. It has exerted influence upon the States to avoid use of planting stock for landscape and related private uses in competition with commercial nursery stock.

Experience has proved that satisfactory production and distribution of suitable trees for forest planting has not been attained in the absence of public assistance and guidance. The commercial production of forest stock is still undeveloped in most sections of the country. The State forestry departments are showing the way by producing these small trees in quantity and at minimum cost. When the market is sufficiently developed, it is possible that commercial nurseries may find it profitable to engage in production of forest trees of suitable species and size and at such prices as would make forest planting feasible, as some of them are already doing to a small extent. The interest in trees which has been stimulated by public activity in forest planting has, it is confidently believed, increased the business of nurserymen in other lines, such as fruit, nut, and decorative tree stock. The farmer cannot afford to plant his waste lands unless the planting stock can be bought at a low figure, a figure much lower than that contemplated by nurserymen before the practice of raising small trees for forest planting was established, by State and Federal agencies. The purpose of the law is to enable him to get the kind and quantity of forest trees needed for his special uses at a cost which he can afford.

It has been estimated that there will remain in the United States a total of approximately 70 million acres of land now in a poor stage of restocking, deforested, and submarginal argiculturally, which will not become satisfactorily restocked within the next 40 years without planting. How much it may be economically advisable to plant will be determined on the basis of our forest needs. But, in any event, this estimate makes it clear that the 1930 program of planting on State and private land, as indicated by table 8, which would take care of less than 100,000 acres, is quite inadequate. The present effort in this line can be considered as essentially educational and demonstrational, and even under that aspect it should be much extended.

COOPERATION WITH STATES IN FARM FORESTRY EXTENSION

Federal cooperation with the States in farm forestry extension was first undertaken on a Nation-wide basis as a result of the Clarke-McNary law, beginning with the fiscal year 1926. Section 5 of that act authorizes and directs the Secretary of Agriculture, "in cooperation with appropriate officials of the various States, or, in his discretion, with other suitable agencies, to assist the owners of farms in establishing, improving, and renewing woodlots, shelter belts, windbreaks, and other valuable forest growth, and in growing and renewing useful timber crops." The usual limitation is provided, namely, that the amount expended by the Federal Government under the section shall not exceed the amount expended by the State, and the amount authorized to be appropriated annually is $100,000.

Farm forestry extension [1] is conducted as a part of the program of the various State colleges of agriculture. Federal cooperation in the work is administered by the Extension Service of the Department of Agriculture, with the cooperation of the Forest Service.

---

[1] The statement from this point to the topic Federal aid to States for roads is contributed by W. K. Williams, forestry specialist of the Office of Cooperative Extension Work, Department of Agriculture, in this activity.

TABLE 9.—*Expenditures for farm forestry extension work in States and Territories, 1915 to 1933, inclusive*

Year	Total	Total Federal	Total within States	Federal funds				Funds within States		
				Smith-Lever	Capper-Ketcham	Clarke-McNary	Additional cooperative	State and college	County	Other
1915	$3, 965. 44		$3, 965. 44					$3, 965. 44		
1916	3, 638. 84	$358. 45	3, 280. 39	$358. 45				3, 280. 39		
1917	9, 558. 50	4, 591. 58	4, 966. 92	4, 591. 58				4, 966. 92		
1918	5, 099. 82	1, 201. 41	3, 898. 41	1, 201. 41				3, 898. 41		
1919	9, 499. 45	2, 089. 12	7, 410. 33	2, 089. 12				7, 410. 33		
1920	10, 694. 57	2, 248. 18	8, 446. 39	2, 248. 18				8, 446. 39		
1921	10, 936. 54	1, 183. 59	9, 752. 95	1, 183. 59				9, 752. 95		
1922	13, 201. 60	409. 84	12, 791. 76	409. 84				12, 791. 76		
1923	14, 187. 56	4, 526. 43	9, 661. 13	4, 526. 43				9, 661. 13		
1924	18, 928. 99	9, 184. 80	9, 744. 19	9, 184. 80				9, 744. 19		
1925	30, 918. 78	7, 053. 51	23, 865. 27	7, 053. 51				23, 865. 27		
1926	82, 537. 27	33, 250. 37	49, 286. 90	1, 230. 03		$32, 020. 34		49, 286. 90		
1927	115, 836. 77	47, 724. 26	68, 112. 51	4, 472. 60		43, 251. 66		67, 795. 84	$316. 67	
1928	127, 658. 44	54, 468. 65	73, 189. 79	3, 804. 14		50, 664. 51		71, 036. 27	800. 00	$1, 353. 52
1929	132, 198. 86	57, 565. 06	74, 633. 80	4, 826. 69	$1, 050	51, 688. 37		74, 357. 35	249. 11	27. 34
1930	145, 660. 00	59, 817. 73	85, 842. 27	4, 599. 52		55, 218. 21		85, 842. 27		
1931	161, 208. 63	66, 612. 59	94, 596. 04	6, 570. 63		59, 552. 05	$489. 91	94, 570. 45		25. 59
1932 [1]	159, 963. 00	69, 934. 00	90, 029. 00	8, 584. 00		61, 350. 00		90, 029. 00		
1933 [1]	151, 226. 48	72, 005. 68	79, 220. 80	9, 695. 68		62, 310. 00		79, 041. 80	179. 00	
Total	1, 206, 919. 54	494, 225. 25	712, 694. 29	76, 630. 20	1, 050	416, 055. 14	489. 91	709, 743. 06	1, 544. 78	1, 406. 45

[1] Estimated.

FEDERAL FUNDS

Most of the Federal funds used in farm forestry extension are made available under section 5 of the Clarke-McNary law. A smaller amount comes through the Smith-Lever law. Table 9 shows all the Federal funds used and the expenditures, by years since 1915. The principal Federal fund (Clarke-McNary) is supplemented by an equal amount of State money. In total amount for the entire period shown in table 9, the State funds used considerably exceed the amount of Federal moneys expended. Most of the Federal appropriation is used in payment of part of the salaries of State extension foresters, who are the leaders in the extension programs in farm forestry in the 33 States and 2 Territories now cooperating under section 5 of the Clarke-McNary law, the Smith-Lever law, or both.

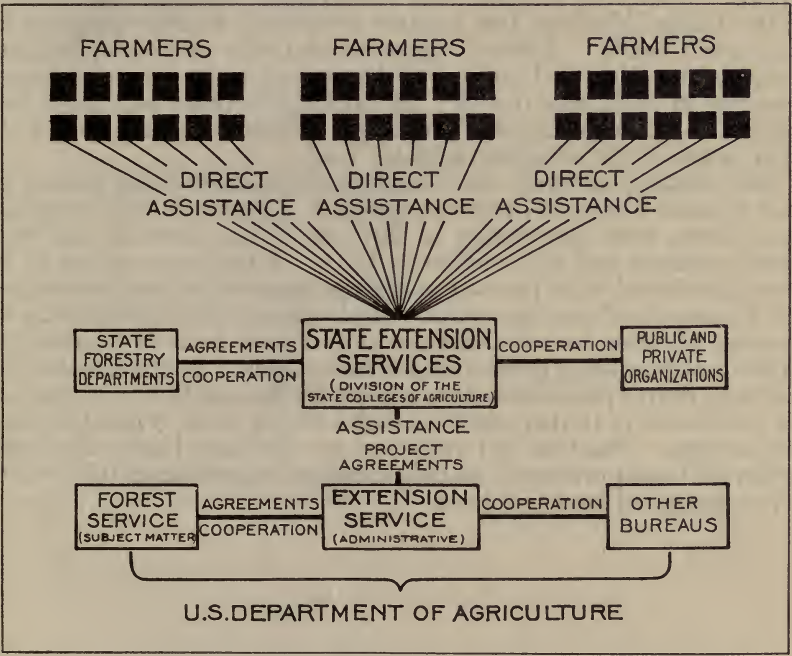
FARMERS
FARMERS
FARMERS
DIRECT ASSISTANCE
DIRECT ASSISTANCE
DIRECT ASSISTANCE
STATE FORESTRY DEPARTMENTS
AGREEMENTS
COOPERATION
STATE EXTENSION SERVICES
(DIVISION OF THE STATE COLLEGES OF AGRICULTURE)
COOPERATION
PUBLIC AND PRIVATE ORGANIZATIONS
ASSISTANCE
PROJECT AGREEMENTS
FOREST SERVICE
(SUBJECT MATTER)
AGREEMENTS
COOPERATION
EXTENSION SERVICE
(ADMINISTRATIVE)
COOPERATION
OTHER BUREAUS
U.S. DEPARTMENT OF AGRICULTURE

FIGURE 7.—Administration of farm forestry extension under sec. 5, Clarke-McNary Law.

ADMINISTRATION

In administering farm forestry the Federal Extension Service has the cooperation of the Forest Service in professional matters and, through the Forest Service, an indirect contact with the State forestry departments. The latter work with the State extension services in promoting programs and in giving direct assistance to farmers. In figure 7 is seen the administrative and cooperative organization set up for the work. In the main, the administration and extension of forestry in the States is conducted by the State extension services in much the sme manner as livestock extension, horticultural extension, or any other phase of agriculture. The system makes available a total force of 4,444 local field workers (as of June 30, 1931), including county agricultural agents, home demonstration agents, and 4-H club leaders. Not all of this group in the States has carried on forestry work; the number, however, is increasing yearly. During 1931, 878 county agents participated in forestry activities in 46 States, 31 home agents in 7 States, and 95 4-H club agents in 16 States—a total of 1,004 extension agents.

RESULTS

To assist in the profitable management of farm woodlands and reforestation of unused farm lands constitutes the task undertaken by the State extension services in cooperating with the Federal extension service. Since July 1, 1925, when farm forestry funds under section 5 of the Clarke-McNary law became available, definite progress has been made yearly. Table 10 presents statistics of accomplishment. It shows that the total number of farms that had adopted improved practices in 1926 was 10,074. In 1929 the number had more than doubled. The same trend of progress is indicated in practically every other phase of the extension forestry work.

The planting of forest trees on farms continues to be one of the most popular phases of extension forestry. Approximately 26 million forest trees were distributed to farmers during 1930 by the State forest nurseries and 25½ million in 1931. A large percentage of the trees distributed were planted under the direction of the State extension foresters and county agents. In the prairie and plains States the planting of trees for wind-breaks and shelter belts is meeting the problem of providing protection for farmsteads. In the Eastern and Southern States planting is done mainly for the control of erosion and the production of timber products such as fence posts, poles, pulpwood and sawlogs. Planting of forest trees on idle farm lands not needed for agricultural purposes is gaining increased attention in those States having marginal land problems.

TABLE 10.—*Statistical results of work in forestry as reported by all extension agents from 1923 to 1931 inclusive*

Item	1923	1924	1925	1926	1927	1928	1929	1930	1931
Method demonstrations held		1, 336	1, 514	2, 309	2, 849	3, 168	3, 854	3, 881	3, 959
Adult result demonstrations completed	1, 422	1, 719	1, 917	2, 286	3, 358	4, 510	4, 870	5, 748	6, 594
Acres in completed demonstrations [1]	69, 817	71, 436	162, 608	110, 866	133, 693	241, 875	240, 959		
Boys enrolled	175	401	523	1, 263	2, 867	3, 539	4, 796	6, 826	7, 611
Girls enrolled	79	8	45	214	296	492	812	2, 068	3, 009
Boys completing	37	213	291	617	1, 980	2, 333	3, 325	4, 248	5, 634
Girls completing	6	5	17	113	212	386	527	1, 131	2, 243
Transplant beds cared for by club members								448	3, 277
Acres farm wood lot managed by club members	51	121	564	689	3, 449	5, 585	116, 711	11, 297	1, 735
Farms influenced by adult or junior extension work	4, 635								
Acres involved in preceding question	101, 622								
Acres forest or farm woodland planted	1, 878	1, 493	2, 317	3, 872	6, 082	6, 638	5, 334	5, 469	7, 057
Acres involved in preceding question	5, 851	132, 763	11, 458	23, 422	19, 455	16, 471	25, 932	16, 222	79, 913
Farms assisted in forest or wood lot management	965	1, 071	2, 126	3, 412	4, 509	5, 476	6, 013	6, 170	9, 534
Acres involved in preceding question	17, 980	31, 738	35, 135	111, 668	222, 135	307, 224	241, 459	387, 829	615, 932
Farms planting windbreaks	904	817	1, 191	1, 679	1, 924	3, 715	3, 088	3, 872	4, 676
Farms following recommendations as to control of blister rust		437	485	585	1, 592	1, 259	949	968	1, 932
Acres involved in preceding question [1]		137, 290	140, 586	31, 179	249, 808	153, 233	65, 226		
Farms assisted in other ways relative to forestry								9, 119	11, 104
Farms adopting improved practices relative to forestry [1]		5, 628	6, 574	10, 074	15, 807	18, 902	21, 350		

---

[1] Questions discontinued 1930.

In the timbered States east of the Prairies, such management projects as improvement cutting of woodlands, fire protection, and the marketing of timber products have been stressed as features of the State woodland management programs. It will be noted in table 10 that 9,534 farmers were assisted in this work in 1931. The work of these men, considered as demonstrators, has its effect in spreading better farm forestry practices in the respective communities. Other phases commanding local attention in some States have been instruction in sawmill practice, estimating timber, the marketing of Christmas trees, pulpwood, and black walnuts, care of maple sugar orchards, and grading of maple sirup.

In addition to the projects under way with farmers, the State extension foresters are finding an increasing interest in forestry manifested among farm boys and girls in 4-H clubs. Many of these club members are engaged in such projects as establishing forest tree plantations, estimating timber, protecting the farm woods from fire, planting black walnut, establishing school forests, and marketing timber products. Table 10 shows that 10,620 4-H club members enrolled for forestry work in 1931, a larger number than ever before, and that 7,877 completed their projects during the year.

METHODS OF EXTENDING FORESTRY

One method of encouraging better woodland practices has been through the use of State forestry publications. In many States printed bulletins and circulars have been prepared. These publications have been supplemented with an increasing amount of mimeograph material, folders, handbills, envelope inserts, and leaflets, besides bulletins furnished by the United States Forest Service. Circular letters have come into wide use in connection with campaigns and other special efforts to influence the spread of improved practice. Other educational devices largely employed to further forestry teaching among farmers are woods demonstrations, exhibits, meetings, tours, news stories, monthly news letters, and radio.

COOPERATION

For the success of farm forestry extension the whole-hearted cooperation of all agencies in the forestry and agricultural fields is necessary. The cooperation of State forestry departments, particularly, is essential to the proper development of the program. In most cases there are working agreements between the State extension services and the forestry departments, and their cooperation has been of mutual benefit. The cooperation accorded by State forestry departments includes assistance in financing the project, technical advice, publication of forestry bulletins, and growing and distribution of forest-tree seedlings for farm planting.

The active cooperation of many other agencies has contributed to the success of the extension forestry work. Among them should be mentioned the farm bureaus, county and community organizations, lumber companies, State and Federal experiment stations, State departments of game and fishery, State departments of education, civic clubs, conservation organizations, women's clubs, railroad companies, and the press.

FEDERAL AID TO STATES FOR ROADS

Until the period immediately preceding the present century, the counties and towns or similar units of government had entire jurisdiction over the construction and maintenance of highways. Prior to 1900, however, the States began to aid the local units in establishing highways of State-wide significance.

With the advent of the automobile, the need for Nation-wide systems of roads began to be keenly felt, and on July 11, 1916, by the Federal Aid Road Act of that date, the Federal Government entered upon the now well-known Bankhead plan of taking the lead in modern highway development, under which a total of $1,005,381,470 of Federal money has been spent up to June 30, 1932. This has been applied to the construction and maintenance of 101,389 miles of roads and bridges, the total cost of which has been $2,296,431,593. The distribution by regions is shown in table 11.

The effect of road extension and improvement upon the protection and utilization of the forests has been great. Better roads have brought the products of the forest nearer to market and thus increased stumpage values in localities that were formerly inaccessible. They have greatly facilitated the attack upon forest fires and thus reduced protection costs. Roads have, however, exerted an adverse influence of grave import in some localities through greatly increased fire occurrence due to the carelessness of the traveling public.

TABLE 11.—*Cost and mileage of Federal-aid roads*

[Totals as of June 30, 1932]

Region	Total cost	Federal-aid funds	Miles
New England	$113, 269, 101. 01	$43, 180, 751. 72	2, 720. 5
Middle Atlantic	357, 883, 875. 18	124, 619, 645. 46	7, 848. 7
Lake States	242, 373, 481. 43	104, 659, 405. 42	14, 143. 8
Central	640, 321, 834. 99	278, 710, 829. 45	25, 802. 5
South	564, 338, 595. 51	250, 859, 581. 72	27, 718. 3
Pacific coast	143, 508, 631. 00	66, 439, 273. 05	5, 029. 1
North Rocky Mountain	55, 460, 702. 52	31, 788, 024. 70	4, 215. 8
South Rocky Mountain	175, 335, 515. 81	103, 833, 541. 14	13, 834. 1
Hawaii	3, 939, 855. 79	1, 290, 417. 84	76. 3
Total	2, 296, 431, 593. 24	1, 005, 381, 470. 50	101, 389. 1

The highway program would go forward without reference to the forests and does not need extended treatment here. The Federal Aid Road Act represents, however, by far the greatest extension of Federal aid to the States and is of importance in any discussion of such activities. The more than 1 billion dollars spent thus far by the Federal Government in aid of roads contrasts strikingly with the less than 12 million dollars spent in aid of forestry under the Weeks and Clarke-McNary Acts. The latter sum is only a little more than 1 percent of the former. This ratio may roughly indicate the relative appreciation of needs on the part of the public. By no leap of the imagination does it express the actual relative need which the public has for these two forms of service.

FEDERAL LAND GRANTS TO STATES

Congress has, since 1785, granted land from its public domain to every State in the Union. In cases where States had no public land within their borders, they received scrip for land in other States which the States turned into cash. The area of land so granted reached, at the end of the fiscal year 1931, the enormous aggregate of 203 million acres. In addition, the railroads have been granted approximately 94 million acres representing public interest in the extension of transportation facilities.

The purpose underlying the Land Grant Act of 1785 was to help the States to support their public schools. The furtherance of education has been a dominant motive in the granting of millions of acres of land to the States throughout the Nation's history. Other purposes have, of course, been served. Early in the nineteenth century Congress donated nearly 5 million acres of public domain to aid States in building canals. In 1841, nineteen States received half a million acres each for "internal improvements". The great period of railroad grants came mainly after the Civil War.

The condition upon which States received their grants during the first 75 years was very simple, namely, that moneys received from sales would be devoted to public schools, highways, or to whatever purpose was designated. Some of this land brought the State $3 per acre which a year later was sold for $25 per acre. Other areas were sold by the States for as little as 50 or 60 cents per acre.

It is interesting to note that New York sold its scrip to Ezra Cornell at 60 cents per acre, with the understanding that he should pay for the land as he sold it, and that all receipts over the amount of his obligation would become an endowment for a university. Cornell located the scrip in the white-pine district of Wisconsin and sold most of it at an average price of $6.73 per acre, thus securing for Cornell University an endowment of more than 5½ million dollars. The university's forestry department has, of course, benefited along with other units. Forest land of high value was here involved which could presumably have been managed for continuous revenue. The fact that the forest property was exploited without reference to its continuing timber values represents a highly successful piece of business for New York, the State which the grant was intended to benefit, but it also illustrates strikingly the fact that neither the Federal Government nor the States remotely contemplated that the forest-covered parts of the vast areas granted would be managed as State forests.

During the last 50 years, Congress has imposed more rigid requirements. Certain lands were granted to States on condition that they should be irrigated and prepared for settlement. Title to these lands was to pass only after completion of the designated program. In 1927, 10 States had applied under that provision for lands totaling nearly 8½ million acres, but titles to only a little more than 1 million acres, were approved. In the case of grants to Arizona and New Mexico in 1910, the Governor and the secretary of state were required to approve all investments of funds derived from the "sale of lands, and disposal or sale for any objects other than specified in the law was to be deemed a breach of trust." The areas granted as land or scrip to the several States from 1785 to 1931 are shown in table 12. In this table an attempt is also made to show the amount of forest land which the States still retain of all the Federal lands granted to them. The policies and programs of States in handling the grants are briefly discussed below.

TABLE 12.—*Land and scrip granted to States and Territories for educational and other purposes, 1785 to 1931*

Region	Total Federal land grants	Forest areas now held by States from grants
New England:	*Acres*	*Acres*
Connecticut scrip	180,000	
Maine do	210,000	
Massachusetts do	360,000	
New Hampshire do	150,000	
Rhode Island do	120,000	
Vermont do	150,000	
Total	1,170,000	
Middle Atlantic:		
Delaware scrip	90,000	
Maryland do	210,000	
New Jersey do	210,000	
New York do	990,000	
Pennsylvania do	780,000	
Total	2,280,000	
Lake States:		
Michigan	8,788,000	[5] 62,000
Minnesota	8,372,000	1,230,000
North Dakota	3,164,000	
Wisconsin	6,221,000	192,000
Total	26,545,000	1,484,000
Central:		
Illinois	3,639,000	
Indiana	4,306,000	
Iowa	3,020,000	
Kansas	3,607,000	
Kentucky	353,000	
Missouri	5,574,000	40,000
Nebraska	3,459,000	
Ohio	2,493,000	
Tennessee scrip	300,000	
West Virginia do	150,000	
Total	26,901,000	40,000

Region	Total Federal land grants	Forest areas now held by States from grants
South:	*Acres*	*Acres*
Alabama	2,258,000	[1] 270,000
Arkansas	9,373,000	(2)
Florida	21,970,000	(2)
Georgia scrip	270,000	
Louisiana	11,030,000	25,000
Mississippi	5,021,000	300,000
North Carolina scrip	270,000	
Oklahoma	3,096,000	(2)
South Carolina scrip	180,000	
Texas do	180,000	
Virginia do	300,000	
Total	53,948,000	595,000
Pacific coast:		
California	8,426,000	14,463
Oregon	4,353,000	[3] 33,000
Washington	3,044,000	[5] 1,248,000
Total	15,823,000	1,295,463
North Rocky Mountain:		
Idaho	3,632,000	958,000
Montana	5,870,000	439,000
Total	9,502,000	1,397,000
South Rocky Mountain:		
Arizona	10,539,000	[4] 32,000
Colorado	4,434,000	154,000
Nevada	2,724,000	2,000
New Mexico	12,656,000	[4] 121,000
South Dakota	3,434,000	66,000
Utah	7,464,000	
Wyoming	4,139,000	120,000
Total	45,390,000	495,000
Alaska	21,445,000	(2)
Grand total	203,004,000	5,306,463

[1] Rough estimate.
[2] No data.
[3] Plus 70,000 Eliott State Forest, secured by exchange sec. 16 and 36's.
[4] Represents commercial saw timber stands only.
[5] Includes area secured by exchange.

PRESENT STATUS OF AREAS GRANTED TO STATES

The Alabama Commission of Forestry is making an inventory pursuant to an act passed by the 1927 legislature. This is a rather long job, since no additional funds have been provided for the work. Much of the land has been diverted from purposes for which granted, and many of the sections 16 have been given away outright. The remnant had not been protected or developed as State forests up to 1928, but progress is being made against trespass and larceny and toward insuring that full value is received by the State in case of sale of land or timber. It has been estimated that there may be 270,000 acres of forest land in this remnant.

In Florida all of the land granted except 1,187,342 acres has been conveyed to private owners under various legislative acts. Many of the deeds of conveyance prior to 1877 have never been recorded in the county records, but complete records have been kept since that year. The State forester has no record of the location of forest lands remaining from the original grants. The State has neither protected nor developed the forest lands.

The superintendent of forestry of Louisiana is authorized by law to examine Federal grant lands remaining unsold and to report upon their suitability for State forests. The work has never been done, on account of difficulty in securing the records showing where the lands are located.

The University of Mississippi has title to 23,000 acres designated in 1932 as the University State Forest. The area has been protected from fire since 1927, and the 1932 legislature authorized a contract with the State forestry commission for its protection and management. Mississippi holds about 500,000 acres of common school grant lands, mostly in 640-acre tracts. Much of the area is under lease, but only about one third is used for farming. It is estimated that about 300,000 of the 500,000 acres is forest land. The State forester has proposed a plan of handling whereby ultimate returns from forest products would, he believes, exceed present returns from rents.

In Idaho, of the 3,632,000 acres in original Federal grants, 1,150,000 acres is estimated as having been originally forest land. The State now has 958,000 acres of this forest acreage left, 854,000 acres of which is commercial forest land, among the best in the State. Present values are appreciated by the public. The areas are being protected from fire, and cutting is roughly in accordance with Forest Service standards.

Federal land grants to Montana amounted to 5,870,000 acres, of which 4,000,000 acres are left. In 1927 the legislature provided that State timberland should not be subject to sale, but the timber only. From the best information it appears that of the State land 439,000 acres is classified as forest land, of which 409,000 acres is commercial forest. Little forest land has been lost from Federal grant land through earlier sales. Montana has a fine forest property, largely commercial forest, regulatory laws governing and guarding it, and an appreciation of its value.

Of the 4,434,000 acres of original Federal grant land in Colorado, about 154,000 acres of forest land remains in State ownership. Timber sold from the land in recent years is cut to a 10-inch diameter limit. The State land board has authority to sell timber and other products and may request the advice and assistance of the State forester but is not required to do so. It also has authority to sell any of the public lands of the State not reserved for some special purpose.

In South Dakota, of the original 3,434,000 acres of Federal grant land, 61,000 acres is retained by the State in the Custer State Park, and of this 55,000 acres are forested. The area is well protected and administered as a park. No timber is cut except 250,000 board feet per year for improvements needed. In addition to the above, 11,000 acres of scattered forest land belongs to the State. Sales on these lands, when they are not too far from the headquarters of Custer State Park, are supervised to insure good forestry practice.

In Kansas and Nebraska the Federal grants consisted almost entirely of farm and grazing land.

Although Wyoming received 4,139,000 acres of Federal grant land, the total forest land now owned by the State is 120,000 acres in scattered locations. The State land board has jurisdiction. Timber on school sections within or adjacent to national forests has been marked for cutting by national forest officers. Otherwise there has been no consistent attempt at forest management. Areas of State-owned forest land not included in the national forests are largely unprotected.

The States of Arizona and New Mexico have still in State ownership approximately 153,000 acres of forest land remaining from their Federal land grants. Cutting on State land is handled by the Forest Service at State expense, in the same manner as on national forest land.

Only about 2,000 acres of commercial timberland remains to the State of Nevada from Federal grant land.

In Utah the State has exchanged its forest lands for farm and grazing lands or has sold them as rapidly as possible. Its past policy has not recognized that any of its grant lands have a permanent value for forest purposes and should be managed to that end. Its authorities are now anxious that the Federal Government take over the responsibility for the handling of all remaining State forest land within its boundaries.

In Washington and Oregon, as in other land-grant States, continued use of Federal grant land for timber production was not contemplated. The nature of the grants tended to make considerations of management for timber production very remote and apparently impracticable. In Washington the enabling act stipulated as a condition of sale of grant lands the securing of such a high price that the State still has most of the timberland, and it has had the advantage of rising prices in its sales of stumpage. Efforts to consolidate have been in part successful and will be continued. It is reasonable to expect that eventually the original grants will be put into such shape that they can be managed as State forests. There is little reason to criticise these States for failing in the past to consolidate the forest areas of the grant lands into State forests under management. The opportunity for the profitable management of State forests did not exist.

In the Lake States there is no accurate record as to the part of original Federal grant lands which should be classified as forest land. Forest lands which came by Federal grant have been under forest management only when located within State forests. The latter embrace about 1,434,000 acres of grant lands. These have had the advantage of fire protection, which is steadily increasing in effectiveness and has saved them from being despoiled of their forests as were nearly all the lands which went into private ownership.

The small total of 5¼ million acres of forest land left today in State ownership out of over 200 million acres of land of all classes granted to the States is impressive. The enormous publicly owned domain would have returned to present and future generations vastly greater values than have ever been obtained, if a much larger part of it had been kept in public forests under good management. Short-sightedness in both Federal and State Governments must now be acknowledged, however much the wholesale disposal of grant lands may have meant to States in the pioneer days in the way of cash for education and for the development of transportation.

FEDERAL AID TO STATE AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS

The first form of Federal aid to the colleges was in land. In 1862 the Morrill Act offered units of 30,000 acres to each State, according to its numerical representation in both houses of Congress. The offer was conditioned on the establishment of a college of agriculture within a stated time. Scrip was awarded to States in which there was no Federal land. No limitations were imposed as to the price for which the land was to be sold. Eventually every State availed itself of the benefits of this act.

In 1890 the second Morrill Act provided an annual appropriation for the support of each State agricultural college, which appropriation was gradually to rise to the present $50,000 annual maximum. All the States and three Territories receive this aid.

The total Federal appropriation to land-grant colleges for the fiscal year 1933 was $2,550,000. The total of endowments built up from the land grants made to the colleges under the act of 1862 is about $22,000,000, which under ordinary conditions brings a total revenue of about $1,000,000 per year. The Federal funds provide only for instruction in agriculture, mechanical arts, English, and science. No part of these funds, principal or interest, is to be used for buildings. Here a degree of supervision is indicated which is characteristic of later Federal aid legislation.

In many State colleges of agriculture provision is made for forestry schools or forestry courses along with other lines of education. Thus, forestry has participated indirectly in the support which Federal funds have given to the mother institutions. Forestry courses are now being given in the colleges of agriculture of the States listed below. To designate the nature of the forestry teaching, one or more numbers follow the name of each State. (1) is used to designate instruction leading to a degree in forestry, (2) ranger courses, (3) short courses in forestry, and (4) courses in range management. The list of States is:

Alabama (3); Arkansas (3); Arizona (4); California (1), (3), (4); Colorado (1), (3), (4); Connecticut (1), (3); Delaware (3); Georgia (1), (3), (4); Idaho (1), (3), (4); Illinois (4); Indiana (1); Iowa (1), (3), (4); Kansas (3), (4); Louisiana (1), (3); Maine (1); Massachusetts (3); Maryland (3); Michigan (1), (4); Minnesota (1), (3), (4); Montana (1), (4); Mississippi (3); Nebraska (4); Nevada (4); New Hampshire (1), (3); New York (1), (3), (4); North Carolina (1), (3); North Dakota (3); Oklahoma (3); Oregon (1), (4); Pennsylvania (1), (2), (3), (4); Rhode Island (3); South Carolina (3); South Dakota (3); Utah (1), (3), (4); Vermont (3); Virginia (3); Washington (1), (2), (3); Wisconsin (3).

Just what this Federal aid to agricultural colleges means in dollars and cents to forestry cannot readily be ascertained and will not be here attempted.

By the Hatch Act of 1887, strengthened by the Adams Act of 1906 and the Purnell Act of 1925, there was established a plan to aid in the establishment of experiment stations in connection with the agricultural colleges. The Federal appropriation for State agricultural experiment stations for the fiscal year 1933 was $4,374,000 a comparatively small part of which is devoted to forestry.

VOCATIONAL EDUCATION

By the Smith-Hughes Act of 1917, a plan was set up for "cooperating with the States in paying the salaries of teachers, supervisors, or directors of agricultural subjects," as well as "in preparing teachers, supervisors, and directors of agricultural subjects and teachers of trade and industrial and home economics subjects." The administration of this act was placed in the hands of the Federal Board of Vocational Education.

It appears that Federal aid has served as a powerful stimulus to the development of State programs of vocational education. The number of federally aided schools increased fivefold during a 9-year period and the number of teachers and pupils about as rapidly. In 1932 there were 1,075,510 pupils and 28,368 teachers.

This activity is significant for its influence upon forestry. In some of the States, as in Georgia, Florida, Mississippi, and South Carolina, the vocational agricultural teachers are carrying on important work in forestry. Many of the schools have established small demonstration forests, which are being developed by the students. In many of these schools, also, effective programs of forestry instruction are being carried on. A very promising field, just beginning to be cultivated, for the extension of forestry interest and practice lies in cooperation between State forestry departments and the vocational agricultural schools.

THE NATIONAL FORESTS AS A FORM OF FEDERAL AID TO THE STATES[1]

L. F. KNEIPP, Assistant Forester, Forest Service

CONTENTS

Page
Relationship of the national forests to the general forest situation 1095
Historical background of national forest system 1096
The direct consequences of national forest administration 1098
Details of the 1927 study of national forest relationships 1101
The financial status of national forest administration, 1923–27 1104
Effect of national forests upon costs of local government 1106
Probable costs of local government without national forests 1109
The probable situation if the national forests had not been created 1110
  Best lands privately appropriated and taxed—residual lands protected by States 1111
  If the national forests had instead been administered as State forests 1118
General summation of results of study 1121

RELATIONSHIP OF THE NATIONAL FORESTS TO THE GENERAL FOREST SITUATION

The basic problem of forestry is the adequate protection, development, management, and controlled utilization of approximately one fourth of the total land area of the continental United States. This requires large capital outlays and current expenditures for (1) the permanent organizations essential to effective protection, improvement, management, and research; (2) protection against fire, insects, and diseases; (3) construction and maintenance of the physical improvements requisite to the protection and use of the natural resources; and (4) forest planting, sanitation, and other cultural operations demanded by sound principles of silvicultural management.

Such expenditures, in the main, are long-time investments. Only a small proportion is capable of early financial liquidation. Long-time credits and low rates of interest are imperative requirements. Relatively few of the States and only a minor proportion of the owners of private lands are able, under prevailing financial and economic conditions, to make available the funds requisite for the complete and adequate protection, development, improvement, and management of all the forest properties within their borders or under their control, to the degree dictated by major considerations of public interest. If the Federal Government failed to participate in certain phases of the problem, the entire enterprise of forestry in the United States would verge on failure.

The retention or establishment by the Federal Government of actual ownership of certain parts of the forest land area, and the assumption of all costs incident to their protection, development, improvement, and management, including the manifold phases of forest research essential to those ends, was motivated primarily by considerations of national welfare and security. The forests administered by the Federal Government are national in purpose and result, as well as in ownership and management. But one important consequence of the national-forest policy is that the burden upon the States, counties, and private owners is measurably reduced, while their enjoyment of the economic and social potentialities of the forest lands continues undiminished—is, in fact, enlarged and made more permanent and systematic.

---

[1] In this section, expenditures and receipts recorded are actual total disbursements made and revenues derived during periods indicated. They therefore differ from the cost figures in other sections of the report, which treat certain forms of expenditure as capital investments and charge as annual costs only the amounts required to cover interest costs and amortization of such capital investments.

In pursuance of this policy the Federal Government, since 1891, has established 148[2] national forests situated in 31 of the States and in Alaska and Puerto Rico. Within these administrative units it owns, or is in process of acquiring, 161,360,691 acres of lands. The national forests in the continental United States with a total net area of 140 million acres, comprise 7.36 percent of the total land area. Not all of this area, however, is true forest land, since the national forests inevitably embrace large areas above or below the altitudinal limits of timber growth, and other lands supporting vegetation, brush, and trees of great importance to streamflow stabilization but not capable of producing timber of commercial sizes and species within practical limits of time. The acreage of true forest lands under Federal control within the national forests in the continental United States is estimated to be 74,679,000 acres, or approximately 15 percent of the total area of forest land in the States.

HISTORICAL BACKGROUND OF NATIONAL FOREST SYSTEM

The initial action by the Federal Government was as the custodian of the public lands. By the act of March 3, 1891 (26 Stat. 1103), it inaugurated the policy of withdrawing the federally-owned forest lands from processes of destructive exploitation and by the act of June 4, 1897 (30 Stat. 34), it initiated the policy of regulated use and occupancy of the lands so withdrawn.

But the problem of forest conservation was most acute in States or regions in which there were either no public lands at all or only very limited and widely distributed areas of public lands. Here the interest of the United States was not one of custodial management of public properties but rather of national welfare. The rapid and destructive depletion of forest resources was creating a condition of economic insecurity. The deforestation of the watersheds of important streams was diminishing their navigability in interstate commerce and was causing widespread and remote damage both physical and economic. The States in which this situation existed were not prepared to meet it in an effective and adequate way. Public ownership and management of the areas in which the situation was most acute was imperatively necessary. To accomplish this the Federal Government initiated the second phase in its program of forest-land management through the enactment of the act of March 1, 1911 (36 Stat. 961), and eventually the act of June 7, 1924 (43 Stat. 653), under which acts it has developed and placed under administration east of the Great Plains 41 national forest units within which the

---

[2] Not including three Wisconsin areas which although constituting an important administrative unit and representing substantial expenditures have not yet been formally proclaimed as national forests.

United States now controls 7,231,555 acres of land, of which 4,727,680 acres have been acquired by cash purchase under the provisions of the acts above mentioned. Figure 1 shows graphically the year-to-year trend in (A) the total national-forest area and (B) in the area acquired by purchase under the Weeks law and the amendatory Clarke-McNary law.

A brief discussion of the facts and circumstances leading up to the adoption of this policy may, perhaps, be warranted.

Immediately prior to the turn of the century the general trend of forest land utilization created grave and widespread concern. Processes of utilization were destructive and negative to future economic and social progress and welfare. Concerted and systematic action to check the tremendous losses due to fire, insects, and disease was almost wholly lacking. Vast areas of land were in large degree denuded of their chief elements of economic and social service, and wherever this condition prevailed it was marked by dying industries, abandoned towns, economic maladjustments, eroded soils, impaired navigability of streams, and the replacement of scenic beauty and inspirational quality by ugliness and devastation. The obvious trend constituted a definite menace to national ideals and objectives and economic security.

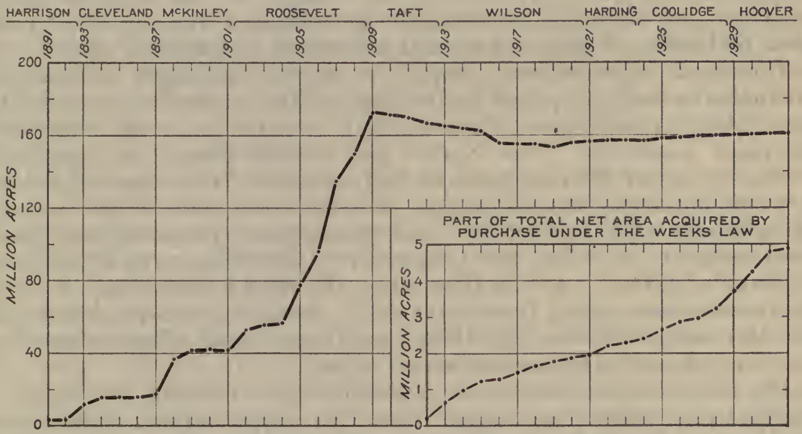

FIGURE 1.—Total net areas of national forests by years.

Preponderant opinion agreed that some form of remedial public action imperatively was necessary to check this demoralizing trend. The direct and immediate effects of the trend were local, but its ultimate ramifications and consequences were national. By emphasizing different factors in the equation it was possible to place primary responsibility for remedial action with either the county, the State or the Federal Goverment. Generally, three major courses of action were open to consideration, namely:

1. Continuation of prevailing principles of private land management and public land appropriation, depending on either voluntary or enforced private action to conserve adequately the forests in private ownership (*a*) without any public effort to protect or conserve either abandoned or unappropriated lands (a wholly impossible formula), or (*b*) with only superficial State or county protection and

conservation of lands remaining or revested in public ownership (a markedly inadequate formula), or (*c*) with adequate State or county protection and conservation of lands remaining or revested in public ownership.

2. Establishment of extensive systems of permanent State forests, through which the States largely would redeem the public responsibilities of forest protection and conservation.

3. Establishment of extensive systems of national forests, through which the Federal Government would assume a share of the public responsibility of forest protection and conservation and, to that degree, make it possible for the several States to meet more effectively a vital problem of public welfare and necessity.

The effectiveness of course 1 would have been contingent upon the successful accomplishment of a vast program of legal, political, and economic readjustments involving many revised or new concepts of public and private functions. In relation to the urgency of the situation, its possibilities markedly were limited and its fullest practical realization dependent upon a prolonged educational effort.

Course 2 likewise was subject to many seemingly insuperable obstacles to early adoption, in the form of State constitutional limitations, legal restrictions, diverse land ownerships, and inadequate financial resources. Few States had constitutional or legislative authority to establish systems of State forests of even limited extent; few could divert from other uses the funds requisite to the acquisition, development, protection, and management of acreages of forest land sufficient to offset the progressively widening area of depleted or denuded forest. At the time when the need for affirmative action in forest conservation became acute, it would have been impossible for the several States and their constituent units of government to have met the situation in any effective way.

By force of circumstances, Federal action became inevitable in support of, rather than competitive with, State action. The States could not fully meet the situation without the aid of the Federal Government. The establishment of national forests was a very definite form of Federal aid. Every acre given a national-forest status and protected, developed, and administered at Federal expense correspondingly diminished the magnitude of the problem demanding State and county action and made it possible for those agencies more effectively to meet the phases of the situation which were within their exclusive fields of action.

THE DIRECT CONSEQUENCES OF NATIONAL FOREST ADMINISTRATION

By the establishment of a national forest the State or county in which it is situated is relieved from all costs of public forest protection related thereto except those incident to lands actually owned by the State or county. The Federal Government at once establishes a resident organization to protect, develop, and administer the lands and to conduct all processes of management and research requisite to their highest use and service. All physical improvements essential to the proper protection and utilization of the national-forest lands, such as forest highways, development roads and trails, lookout towers, telephone lines, administrative structures, fences, etc., are constructed at Federal expense, except where special circumstances warrant cooperative contributions of State, county, or other funds. The Federal expenditures not only relieve the State and counties from proportionate drafts upon their funds but release in each region sums which contribute markedly to that region's economic security. The benefits from these expenditures are not confined exclusively to the federally-owned lands but are reflected over such State, county, or private lands as are situated within or contiguous to the national-forest boundaries, thus aiding appreciably in promoting the effective and economical protection and management of such lands.

All privately owned improvements or other property on national-forest lands are subject to State or county taxation, but the national-forest lands are not. As an offset, however, Congress has provided, Act of May 23, 1908 (35 Stat. 260), that 25 cents out of every dollar collected from the sale of national-forest resources or use of national-forest lands shall be paid to the State in which collected, for proportionate distribution to the counties embracing the national forest in which it was earned, for the support of schools and roads. This payment, in effect, is equivalent to the form of taxation known as the severance tax, but is a larger proportion of gross revenues than most taxes of that character.

Congress also has provided, Act of March 4, 1913 (37 Stat. 843), that 10 cents out of every dollar derived from the sale of national-forest resources or uses of national-forest land shall be expended by the Secretary of Agriculture for the construction and maintenance of roads and trails within the national forests of the State in which the revenues were derived. The roads and trails constructed and maintained with this fund are of substantial benefit to the counties in which they are situated and otherwise largely would be provided at public or private expense, consequently this additional 10 percent of national-forest revenue properly may be regarded as a further offset to the taxes which might be collected if the national-forest lands were subject to private appropriation and attendant local and State property taxes.

In addition, Congress, since 1916, has made large appropriations for road and trail construction on lands within or adjoining the national forests. At the close of the fiscal year ending June 30, 1932, the total expenditures for road and trail construction, improvement, and maintenance, including the 10 percent of national-forest receipts (exclusive of Alaska) amounted to $116,095,330, an average of 83 cents for each acre of land now reserved in the States for national-forest purposes. One provision of these appropriations is that the larger proportion thereof shall be expended upon roads of primary importance to States, counties, and communities which in the absence of Federal funds necessarily would be constructed and maintained wholly at State or local expense. The availability of these Federal funds thus has enabled State and county governments to extend and improve their road systems more rapidly and at less cost to the local taxpayers than otherwise would have been the case.

Upon these lands thus reserved from the Federal domain or acquired by purchase, the United States has established administrative organizations, systems of protection against damage by fire, insects, disease, etc., and effective machinery for the regulation of logging, the grazing of domestic livestock, the use of water resources, and the use of land for purposes of industry, recreation, etc. It has definitely inaugurated advanced systems of silvicultural management, including the planting of denuded areas. It has established or is in process of establishing the systems of physical improvements essential to the proper protection, utilization, and occupancy of the areas such as roads, trails, bridges, telephone lines, administrative structures lookout towers, etc. It has developed methods and principles under which the industrial or economic use of the natural resources of the areas is equitably apportioned between the industrial or commercial groups and interests dependent upon the use of such resources.

Finally, it has conducted a large program of forest research, not only applying the results thereof to the lands under Federal management but also making them available for applications to all other forest lands where similar conditions prevail. In consequence of this action by the Federal Government wide-spread benefits have accrued to all of the States within which the national forests are situated. Some of these are abstract and intangible; the majority are direct and concrete and of large proportion.

The outstanding benefit to local interests which accrues through national-forest administration is the stability and permanency of local industries which results. The natural resources are protected from fire, insects, disease, and destructive forms of use. Their volume and utility are increased by constructive forms of management and development. Their utilization is conducted in an orderly manner and with a view to securing permanent and sustained production of the most complete character compatible with the preservation of the basic natural capital. Opportunity to use these resources to meet personal needs or for purposes of industry and profit is afforded under conditions which secure equitable distribution and the best net contribution to local welfare and prosperity. Certainty of future economic security and permanency of community and industrial growth and development thus is created and reflects itself in every phase of industrial life of the community.

A second contribution to public welfare, of far-reaching consequences is the element of watershed protection. With each passing year water becomes more and more indispensable to the industrial and community life of the Nation, so that effective watershed protection is a matter of vital consequence. Where no national forests exist, watershed protection is entailing an increasing burden of public and private expense. States or parts of States whose watersheds are embraced within national forests secure satisfactory watershed protection without direct outlay. The needs of municipalities adequately are met and safeguarded and every effort is made to maintain the stability and purity of streamflow essential to the full utilization of water resources.

A third benefit is the contribution to wild-life conservation. The availability of extensive areas of national-forest lands as suitable habitats or environments for wild life permits the fullest public development and most complete use and enjoyment of this resource at a minimum of local public or individual cost. If the national forests did not supply these facilities they would have to be provided in other ways at local expense. The cooperation of the national-forest organization in game-law enforcement and fish planting relieves the States and counties of substantial expenditures for these purposes which otherwise would be imperatively necessary.

Still another public benefit of outstanding proportions is the conservation and development of the extensive recreational resources contained within the national forests. The economic and social values of such resources are fully recognized, they are safeguarded and improved, and their full and free enjoyment by the general public is allowed under a minimum of regulation and restriction. As a result, such values are assuming large proportions and are becoming important factors in promoting the commercial development and material prosperity of the regions in which they exist.

It safely may be asserted that the officials and citizens of the majority of the political units that contain national forests now concretely recognize the existence and magnitude of the direct and indirect national-forest contributions to local welfare above enumerated. As the old order has changed, public thought has changed. The need for standards of protection and management such as prevail in national forests is becoming more and more generally recognized and accepted by the citizens of the national-forest States and counties, but combined with this there exists a realization that as a rule the States and counties are unprepared, financially and otherwise, to assume at this time or in the near future the burdens entailed by such standards of protection and management.

The fact that the more equitable apportionment and lower cost of national-forest resources reflects itself in community welfare and prosperity; that the stability and permanency of industrial and community life promoted by established principles of national-forest management permits communities to build for the future with certainty and security, thus creating stable rather than speculative values, is less and less disputed with each passing year.

Nevertheless, proposals have from time to time been made for increases in the State shares of gross receipts from national forests. In support of such proposals it has been represented that if the national-forest lands had remained open to free appropriation and consequent taxation, or if they had been ceded to the respective States for administration as State forests from which the States would derive all revenues over and above the costs of protection and management, the returns to the States and counties involved markedly would have surpassed those derived directly and indirectly from the national forests. This viewpoint was particularly manifest in 1927, at which time two bills to increase the State share of national-forest revenues were before Congress. The circumstances dictated a detailed study of the situation, which was made, covering the fiscal years 1923 to 1927 inclusive.

DETAILS OF THE 1927 STUDY OF NATIONAL FOREST RELATIONSHIPS

The period covered by the study affords perhaps a clearer and truer picture of the national forests as a form of Federal aid to the States than would a similar study under current conditions. It was a period of abnormal financial and economic ease. The Federal Government's part was not influenced by considerations of depression relief which more recently have materially increased its expenditures in the national forests. The standards, objectives, plans, and programs of the States, counties, and private owners were relatively uninfluenced by considerations of financial or economic exigency. For these reasons the results of the 1927 study are used for the purpose of this analysis.

The subject naturally divided itself into four major questions, namely:

1. The true measure of the Federal contribution toward the solution of the national economic and financial problem through the media of the national forests.

2. The degree, if any, to which the establishment and Federal management of the national forests imposed upon the States and counties additional burdens of cost in the discharge of their functions of local government.

3. For purposes of comparison, the probable financial consequences to the States and counties if the public lands, instead of being reserved for national-forest purposes, had continued subject to private appropriation under the land laws of the United States, with the States assuming responsibility for the protection and management of the unappropriated residue and deriving from the lands the taxes payable upon those privately appropriated and the revenues obtainable from those remaining or revested in public ownership.

4. For further purposes of comparison, the probable financial consequences to the States if the lands reserved for national-forest purposes had instead been ceded to the States for administration as State forests from which the States would derive all revenues over and above the costs of protection, development, administration, and management.

To attain a true understanding of the situation, an effort was made to compile the following data for each county containing substantial areas of national-forest land:

(*a*) The acreage of privately owned taxpaying lands, exclusive of town and city property or of improvements, in each such county; the total annual tax paid by such lands; the percentage of total county income represented by such tax payments; and the average tax return per acre of taxable land. Coupled with this was a study of lands on which taxes had been delinquent three or more years.

(*b*) The total acreage of lands in State or county ownership to which title had been established by grants from the Federal Government, the total revenues derived from such lands, the percentage of county income represented by such revenues, and the average return per acre. Coupled with this was a similar study of the lands which had reverted to State or county ownership through tax delinquency.

(*c*) The total contributions secured by the local taxing units from the national forests in the form of direct payments from national forest receipts; taxes upon privately owned improvements, Federal payment of costs of road and trail construction and maintenance; cooperation in fish and game protection; and benefits, such as free use by citizens of timber and forage, difference between sale values of timber and prices paid in sales at cost, value to State, private, and outside lands of Forest Service protection against fire, tree diseases, insects, etc.; these factors being reduced to total amounts, returns per acre, and comparisons to total county income.

(*d*) The estimated probable returns to States and counties from the national forests, when through more complete utilization and better management they become fully productive.

(*e*) The potential taxability of national-forest lands, i. e., the acreage which probably would be privately appropriated if the national forests did not exist; the probable assessed valuation of such land if privately owned; the probable tax yield; and the probable return per acre distributed over all national-forest lands in the unit.

(*f*) The average annual cost of national-forest administration by separate activities during the preceding 5-year period.

(*g*) The present cost to States, counties, and private owners of road and trail construction and maintenance; protection of forest lands against fire, insects, and disease; protection of fish and game; maintenance of schools for residents within national-forest boundaries; enforcement of civil and criminal processes; and assessment and collection of taxes on lands within national-forests.

(*h*) An estimate of what the above-described costs to States, counties, and private owners would be if the national forests did not exist.

(*i*) The extent and cost of present State or county activities in forest protection.

The project as planned did not contemplate field studies or appraisals of land. The Forest Service had neither the men nor money with which to examine private or State and county holdings, and data regarding national-forest lands were already available in the form of a detailed land classification prepared pursuant to the act of August 10, 1912 (37 Stat. 287), and representing the results of eight or more years of careful work by highly qualified members of the Forest Service and other Bureaus of the Department of Agriculture. The study, therefore, was confined to a compilation of pertinent facts and figures from the best available State, county, Forest Service, and other records from which the desired data could be secured without an undue outlay of time or money.

Experience proved the impossiblilty of making the study in the complete detail originally contempletad. It was dependent in major part upon the data available in State and county records, which vary widely in methods of arrangement, in completeness, and in detail. In some units, excellent records are maintained, consistent classifications of property are used and adequate summaries or analyses are currently compiled. In other units, records are poorly maintained and confusing; division of taxable property into classes is not systematic or consistent; specific summaries or analyses are not available; and approximations based upon the best judgment of present official incumbents sometimes were necessary. No facts were intentionally omitted. Their absence, where it occurred, was because they were not reasonably obtainable.

For the reasons given, the figures herein presented are not regarded as 100 percent accurate. In view, however, of the large numbers of records consulted, and the tremendous acreages of private land, State lands, etc., reported upon, the returns for all practicable purposes can be accepted as dependable, since such doubtful cases or figures as may exist can not make substantial difference in the major conclusions.

Consideration of all phases of the study above outlined is not essential to this discussion. The data related to the granted or revested lands under State or county control and the annual revenues derived therefrom, or to the areas under administration as State forests and the costs of such administration and their relation to income, afford opportunities for many interesting comparisons. However, they do not specifically apply to the national-forest lands herein discussed.

The contributions made by the national forests during the period of the study are matters of detailed record. It is more difficult to measure the results obtainable under the second method. However, the fact that the national-forest lands had previously been classified in detail permitted reasonably correct comparisons with the lands in private ownership and defensible deductions as to the degree to which the national-forest lands would have been privately appropriated had they not been reserved, the values at which such lands would have been assessed if in private ownership, and the probable tax returns on such assessments. It is necessary arbitrarily to assume the probable revenues obtainable from the residual lands and the probable costs of protecting such lands.

As to the third method it might logically be argued that the net gain or loss under State management would not be greatly different from that actually occurring under Federal management. As a means of minimizing doubts, the comparisons are based upon the assumptions that under State management revenues would be 10 percent greater and costs of protection and administration 20 per cent less than those actually obtained under Federal management, although, as hereinafter indicated, no valid grounds exist for such assumptions.

THE FINANCIAL STATUS OF NATIONAL FOREST ADMINISTRATION, 1923–27

Table 1 is a summarized statement of the financial aspects of national-forest administration during the period of July 1, 1922, to June 30, 1927, as determined by the study above described. The data do not include the costs of national-forest administration in Alaska or in certain counties where the national-forest acreage was too small to warrant the inclusion of the counties in the study. Neither do they include the large previous expenditures for improvements, equipment, and other facilities which tended to minimize administrative costs during the period covered by the study.

TABLE 1.—*Summary of total and net average annual Federal expenditures for local national-forest administration* [1]

State	Expenditures for local administration		National-forest receipts	Payments (25 percent) to States and counties	Net outlay of Federal funds	Proportion of area of counties involved occupied by national forests
	Total	Per acre				
		Cents				*Percent*
California	$1, 913, 382. 27	10. 1	$1, 190, 233. 23	$297, 558. 31	$1, 020, 707. 35	22. 1
Oregon	1, 275, 731. 00	9. 6	717, 953. 27	179, 488. 32	737, 266. 05	22. 6
Washington	1, 107, 820. 47	11. 5	421, 997. 59	105, 499. 40	791, 322. 28	30. 8
Arizona	1, 047, 333. 00	9. 2	308, 463. 84	77, 115. 96	815, 985. 12	19. 4
Colorado	727, 775. 00	5. 5	413, 695. 19	103, 423. 80	417, 503. 61	29. 8
Nevada	94, 776. 00	1. 9	100, 485. 15	25, 121. 29	19, 412. 14	9. 6
New Mexico	784, 605. 00	9. 2	153, 384. 82	38, 346. 20	669, 566. 38	15. 2
Utah	349, 232. 00	4. 7	209, 500. 12	52, 375. 03	192, 106. 91	14. 3
Idaho	2, 180, 944. 66	11. 4	614, 291. 00	153, 572. 75	1, 720. 226. 41	46. 7
Montana	1, 909, 203. 39	12. 0	269, 807. 78	67, 451. 94	1, 706, 847. 55	26. 3
Wyoming	466, 577. 00	5. 5	273, 784. 35	68, 446. 09	261, 238. 74	23. 6
South Dakota	124, 751. 29	11. 7	112, 100. 39	28, 025. 10	40, 676. 00	12. 6
Nebraska	28, 681. 20	13. 9	11, 070. 14	2, 767. 54	20, 378. 60	4. 3
Michigan	20, 119. 40	15. 9	773. 23	193. 31	19, 539. 48	4. 7
Minnesota	130, 192. 45	13. 0	30, 971. 99	7, 743. 00	106, 963. 46	8. 4

[1] All figures shown are yearly averages for period from July 1, 1922, to June 30, 1927.

TABLE 1.—*Summary of total and net average annual Federal expenditures for local national-forest administration*—Continued

State	Expenditures for local administration		National-forest receipts	Payments (25 percent) to States and counties	Net outlay of Federal funds	Proportion of area of counties involved occupied by national forests
	Total	Per acre				
		Cents				*Percent*
Arkansas	$154,697.00	15.7	$77,448.80	$19,362.20	$96,610.40	11.8
Oklahoma	17,945.00	29.2	6,352.42	1,588.10	13,180.68	7.8
Alabama	22,191.00	20.7	676.84	169.21	21,683.37	12.6
Florida	42,396.00	12.4	24,570.97	6,142.74	23,967.77	8.2
Georgia	44,275.00	22.7	9,352.67	2,338.17	37,260.50	14.4
South Carolina	7,445.00	18.1	1,927.57	481.89	5,999.32	9.9
North Carolina	121,293.00	32.2	26,730.08	6,682.52	101,245.44	8.7
Tennessee	77,300.00	23.9	14,360.24	3,590.06	66,529.82	13.0
Virginia	89,905.00	15.7	34,069.61	8,517.40	64,352.79	9.3
West Virginia	46,540.00	20.7	3,697.33	924.33	43,767.00	8.2
Maine	5,500.00	17.1	2,495.46	623.86	3,628.40	2.5
New Hampshire	44,905.00	10.5	31,763.66	7,940.92	21,082.26	14.9
Pennsylvania	53,185.00	24.8	494.56	123.64	52,814.08	10.7
Total or average	12,888,701.13	9.45	5,062,452.30	1,265,613.08	9,091,861.91	21.5

In substance, in 397 counties in the continental United States 136,375,417 acres were under national-forest management during the period of the study. They represented an average of 21.5 percent of the total areas of the counties in which situated, varying from a minimum of 2.5 percent in Maine to a maximum of 46.7 percent in Idaho. During the 5-year period the expenditures of the Federal Government in the protection, development, and management of these lands averaged $12,888,701 per year, including all costs of constructing and maintaining highways, roads, trails, and other physical improvements, but exclusive of the costs of the Washington office, the Forest Products Laboratory, the eight forest experiment stations, and the various activities of the Forest Service not directly related to the actual protection, development, and management of the national-forest lands. These expenditures averaged 9.45 cents per acre per year for the lands covered by the study, the acreage average ranging from a minimum of 1.9 cents in Nevada to a maximum of 32.2 cents in North Carolina.

In offset to these expenditures the national forests yielded revenues averaging $5,062,452 per year. Of this sum, however, $1,265,613 was repaid to the States for distribution to the counties embracing the national-forest lands, so that the average net return to the Treasury was $3,796,839, which, credited against total administrative expenditures, reduced them to an annual average of $9,091,862.

These expenditures aided the States in several specific ways, namely:

1. They increased State and county financial resources by the annual payment of substantial sums, comprising one fourth of the total gross revenues derived from sales of natural resources and uses of lands, without any State or county costs of collection. While it is true that the money thus paid can be used only for school and road purposes, its availability released other State or county funds for other classes of expenditures, including forestry.

2. They substantially reduced the amounts of money which the States and counties had to spend to properly safeguard and conserve natural resources vital to their continued economic and social progress.

3. They markedly reduced the amounts of money the States and counties had to spend to provide and maintain the systems of highways, roads, and trails essential to existing and prospective public needs.

4. They made available to the States and counties for the enforcement of State laws and county ordinances, such as the fish and game laws, fire laws, sanitary laws, etc., the cooperative assistance of a widely distributed and trained organization, and correspondingly diminished the expenditures the local agencies otherwise would have had to make to carry out properly their regulatory functions.

5. They indirectly benefited all State, county, or private lands intermingled with or contiguous to the national-forest lands by minimizing losses from fire, disease, and insects; and benefited the local economic situations by making available to local populations valuable privileges and uses which facilitated local commercial and industrial development and land use, and correspondingly enhanced local values.

Table 2 quantitatively summarizes the extent of these benefits. The first column of figures covers item 1, the second column items 3 and 4, and the fourth column item 5. The figures in the first column are matters of detailed record; those in the second are based on detailed road and trail expenditures and cost distribution records; and only those in the fourth column are approximations.

EFFECT OF NATIONAL FORESTS UPON COSTS OF LOCAL GOVERNMENT

In offset to the evident benefits accruing locally from the national forests, the representation frequently has been made that the existence of national forests markedly increases the general costs of local government. The study herein discussed therefore included consideration of that aspect of the situation.

Primarily the functions of State and county government are:

1. The protection of public safety, health, and property.
2. The enforcement of civil and criminal processes under State law or county ordinance.
3. The promotion of public education.

TABLE 2.—*Summary of national forest contributions to State or county revenues or development programs during fiscal years 1923 to 1927*

State	Direct contribution to revenues or development programs			Additional benefits and privileges to citizens (estimated)
	Average annual payment [1]	Direct aid—roads, law enforcement, etc.	Total	
California	$297, 558	$1, 205, 564	$1, 503, 122	$12, 056
Oregon	179, 488	1, 348, 772	1, 528, 260	19, 443
Washington	105, 500	801, 609	907, 109	13, 468
Arizona	77, 116	624, 091	701, 207	31, 312
Colorado	103, 424	537, 751	641, 175	52, 317
Nevada	25, 121	166, 185	191, 306	2, 944
New Mexico	38, 346	416, 554	454, 900	51, 127

[1] 25 per cent of national-forest receipts.

TABLE 2.—*Summary of national forest contributions to State or county revenues or development programs during fiscal years 1923 to 1927*—Continued

State	Direct contribution to revenues or development programs			Additional benefits and privileges to citizens (estimated)
	Average annual payment	Direct aid—roads, law enforcement, etc.	Total	
Utah	$52, 375	$332, 345	$384, 720	$13, 398
Idaho	153, 573	1, 520, 348	1, 673, 921	88, 933
Montana	67, 452	1, 054, 791	1, 122, 243	43, 641
Wyoming	68, 446	443, 411	511, 857	18, 703
South Dakota	28, 025	79, 985	108, 010	8, 752
Nebraska	2, 768	11, 743	14, 511	302
Michigan	193	1, 863	2, 056	3, 380
Minnesota	7, 743	72, 750	80, 493	18, 939
Arkansas	19, 362	68, 560	87, 922	39, 493
Oklahoma	1, 588	8, 817	10, 405	111
Alabama	169	8, 038	8, 207	2, 956
Florida	6, 143	24, 499	30, 642	929
Georgia	2, 338	13, 954	16, 292	2, 682
South Carolina	482	3, 505	3, 987	893
North Carolina	6, 683	81, 240	87, 923	6, 874
Tennessee	3, 590	31, 048	34, 638	2, 411
Virginia	8, 517	55, 527	64, 044	4, 221
West Virginia	924	19, 369	20, 293	6, 124
Maine	624	3, 432	4, 056	185
New Hampshire	7, 941	34, 469	42, 410	2, 388
Pennsylvania	124	9, 561	9, 685	3, 880
Total	1, 265, 613	8, 979, 781	10, 245, 394	451, 862

4. The development and maintenance of public improvements.

The examining officers experienced great difficulty in obtaining accurate figures on the amounts expended by the counties, the States, and the private owners of land, within the national forests, in road and trail construction and maintenance, the protection of State or private forest lands against fire, insects, or disease, the protection of fish and game, the maintenance of schools for residents within national-forest boundaries, the enforcement of civil and criminal processes, and the assessment and collection of taxes on lands within national forests. In the great majority of cases the county officials were unable to segregate the costs applicable to national-forest areas. Costs of school maintenance were most readily determinable because they represented fixed activities at fixed locations, but frequently only a part of the cost could be charged to national-forest territory. Road and trail construction and maintenance costs were reasonably determinable. The other items of cost specifically chargeable to the national-forest areas were not determinable because they were not segregated from the similar expenditures upon parts of the country not within the national forest.

As a matter of fact, the majority of county and State expenditures are influenced by project activities or by population rather than by area of land. The existence of national forests reduces rather than increases the burden of cost to counties and States. The national-forest lands are protected against fire, insects, and disease at Federal expense without contributions by the county or State except where county or State property is directly involved. State, county, and private lands indirectly benefit from this protection. The Federal Government also cooperates liberally in the development and maintenance of the most expensive classes of public improvements, namely, the roads and trails. Thus, in two important respects, the national forests diminish rather than increase the costs of county government. Although the protection of fish and game is primarily a State function, the State largely is relieved of that responsibility within the national forests through the cooperation of the forest officers. The continued presence and active cooperation of forest officers under present conditions makes it unnecessary for the States to station any game wardens within large areas of national-forest lands. Were it not for the cooperation of the forest officers, the employment of additional game wardens would be absolutely necessary, the total cost of their salaries and expenses being chargeable to the specific areas now within national forests.

The same principle applies to other activities now handled by the field officers of the Forest Service with a minimum of contributed time but which in the absence of such cooperation would require the employment of additional men or the expenditure of additional funds by the State, county, and private interests directly involved. The enforcement of civil and criminal processes is least necessary within the predominantly publicly owned national forests, and the presence within such areas of trained and highly qualified men prepared to cooperate with the local authorities in the enforcement of State laws and county ordinances diminishes rather than increases the expense of such enforcement. Since the national forests normally are the most scantily populated parts of a county, they impose minimum requirements of public education. The return to the county of 25 percent of gross national-forest revenues annually is secured without any process of land assessment or tax collection, so that the counties are relieved of the costs of such work. The assessment and collection of taxes on private lands or improvements within national forests is facilitated rather than hampered by the existence of the forests because of the excellent status and other records available to the State or county officials. The difficulty of securing definite estimates of costs from the State officials themselves is rather a concrete demonstration of the negligible or the wholly minus character of such costs to the county or State.

Subject to these numerous explanatory qualifications, the results of this phase of the study are presented in the first column of figures in table 3.

TABLE 3.—*Approximate effect of Federal administration of national forests upon costs of State and county government and private land management within and adjacent to the national forests for the fiscal years 1923–27*

State	Estimated actual cost of local government and land management			Theoretical cost of local government and land management if there had been no national forests			Increase in costs without national forests
	State	County	Private	State	County	Private	
California	$2,038,718	$1,282,685	$142,383	$2,567,467	$1,992,024	$209,629	$1,305,334
Oregon	692,795	419,698	47,118	1,150,000	839,425	247,800	1,077,614
Washington	739,305	204,675	80,931	1,152,500	454,485	217,500	799,574
Arizona	281,712	581,430	24,830	709,244	971,180	12,429	804,881
Colorado	179,800	587,000	42,240	386,800	805,600	52,600	435,960
Nevada	586	18,200	627	167,300	39,400	654	187,941
New Mexico	41,000	351,750	21,300	322,000	586,400	63,340	557,690
Utah	43,700	52,100	4,800	324,000	174,100	4,800	402,300
Idaho	78,800	271,325	74,500	600,000	767,250	276,000	1,218,625
Montana	85,421	264,039	65,850	258,300	689,100	138,100	670,190
Wyoming	31,062	87,246	131	329,000	168,664	----------	379,225

TABLE 3.—*Approximate effect of Federal administration of national forests upon costs of State and county government and private land management within and adjacent to the national forests for the fiscal years 1923–27*—Continued

State	Estimated actual cost of local government and land management			Theoretical cost of local government and land management if there had been no national forests			Increase in costs without national forests
	State	County	Private	State	County	Private	
South Dakota	$89, 360	$462, 100	$500	$115, 300	$499, 600	$967	$63, 907
Nebraska	400	24, 312	0	3, 050	37, 750	0	16, 088
Michigan	835	4, 055	0	2, 100	5, 130	0	2, 340
Minnesota	26, 045	25, 760	0	32, 045	75, 290	0	55, 530
Arkansas	189, 737	157, 990	71, 340	342, 300	222, 270	85, 740	231, 243
Oklahoma	0	1, 600		3, 050	7, 300	100	8, 850
Alabama	1, 750	7, 704		1, 750	13, 591		5, 889
Florida	7, 826	40, 022		15, 554	74, 925		42, 631
Georgia	3, 425	12, 000		3, 925	21, 125		9, 625
South Carolina		640			877		237
North Carolina		13, 544		768	20, 213		7, 437
Tennessee	11, 605	92, 170		14, 000	102, 720		12, 945
Virginia	10, 240	26, 825	155	13, 370	50, 350		26, 500
West Virginia	2, 300	68, 314	1, 110	4, 930	69, 100		2, 306
Maine New Hampshire	61, 890	179, 880	0	72, 450	196, 100		26, 780
Pennsylvania	16, 965	14, 900	4, 150	26, 600	21, 530		12, 115
Total	4, 635, 277	5, 251, 964	581, 965	8, 617, 803	8, 905, 499	1, 309, 659	8, 363, 755
Increase in costs without national forests				3, 982, 526	3, 653, 535	727, 694	8, 363, 755

PROBABLE COSTS OF LOCAL GOVERNMENT WITHOUT NATIONAL FORESTS

The next step in the study was to approximate the costs which would have had to be borne by the State, the county, and private owners of land, if the national forests did not exist. This was a matter of great difficulty because of the lack of definite information as to the intensity of protection and administration which would under such circumstances prevail. Some reporting officers assumed that if the national forests did not exist, the prevailing standard of protection, management, and improvement would be maintained by other public and private agencies and based their estimates of cost accordingly. Other reporting officers assumed that if the national forests did not exist the lands comprising them would be subject to the indifference and neglect which characterizes many comparable areas not within the national forests, and consequently included in their estimates only the obviously necessary minimum requirements, making no provision for a continuance of constructive standards of forest and watershed protection and management. Some reporting officers assumed that in the absence of the present indirect benefits from national-forest protection, owners of private land would supply, at their own expense, substitute protection against fire, insects, or disease; while others reasoned that the private landowners would merely pay their proportionate share, in the form of taxes, of such additional forest protection as the State or county might provide.

Such figures as were secured, therefore, were incomplete and broadly approximate. With that qualification they also are presented in table 3. They indicate that if national forests had not existed the annual average of $10,469,206 actually expended by States, counties, and private owners, under prevailing circumstances would have been increased to an estimated expenditure of $18,832,961, or an additional sum of $8,363,755. The fact that this estimated increase in cost is more than $4,000,000 below the then prevailing average annual expenditure for national-forest protection and management within the counties covered by reports indicates that it is not an exaggerated estimate. Detailed comparisons of estimated State, county, and private costs as compared to actual national-forest expenditures within specific counties almost uniformly demonstrated that the estimated costs were conservative.

Accepting the returns at their face value, the absence of national-forest management during the period July 1, 1922, to June 30, 1927, would have increased the average annual cost to the counties from an estimated $5,251,964 to $8,905,499, a difference of $3,653,535. The cost to the several States would have jumped from $4,635,277 to $8,617,803, a difference of $3,982,526. The $581,965 expended by private landowners would have been increased to $1,309,659, a difference of $727,694.

To have maintained financial parity with then existing conditions, the States and counties, if they had adequately managed the areas without the aid of the national forests, would have had to derive from these lands incomes as much in excess of what they received under the then prevailing arrangement as their additional expenditures would have been in excess of their approximate actual costs, or, in other words, an increase of more than $7,600,000 over approximate actual expenditures. It is quite improbable that they could have done so. The national-forest resources were being utilized as fully as prevailing economic and industrial conditions allowed, with due regard to the permanency and sustained production of such resources. Substantially greater revenues could have been obtained only through substantially increased charges for resources and land uses; the bulk of the burden of such increased charges would fall largely upon local industries; and the ability of such industries to pay taxes upon their privately owned property would be correspondingly diminished. The net benefits to the county would be debatable.

THE PROBABLE SITUATION IF THE NATIONAL FORESTS HAD NOT BEEN CREATED

Regardless of the degree to which the beneficial consequences of national-forest administration may be quantitatively or otherwise expressed, there may be honest and sincere doubts as to whether some other form of public action would not have yielded larger or more substantial results. Adequate consideration of the entire problem, therefore, demands a discussion of the possibilities and probable consequences of such other courses of action as were capable of public adoption. As previously indicated, there were two other courses available—first, the continued passage to or retention in private ownership of all lands attractive to private initiative, plus State or county management of the residual lands; second, the cession of all public lands to the States for permanent administration as State forests. Since neither of these courses was adopted in relation to the national forests the conclusions as to their probable consequences necessarily must be largely circumstantial and hypothetical. But justification does exist for determining the conditions which actually resulted in relation to comparable types of land within the same regions and subject to the same circumstances and by processes of comparison and analogy applying such conditions to the national-forest lands.

BEST LANDS PRIVATELY APPRAISED AND TAXED—RESIDUAL LANDS PROTECTED BY STATES

As a part of the process of comparison, the reporting officers were asked to make the best possible estimate of the potential taxability of national-forest land and the tax return which might be expected if the national forests were abolished and the lands made freely available for appropriation under the applicable public land laws. Decision as to whether lands of certain types would or would not be appropriated was to be based upon the capacity of the land for profitable production and its adaptability to private use and management, with due regard to actual conditions and results within comparable areas open to private ownership. Probable assessed valuations and probable tax returns were based upon the assessments and tax payments of similar privately owned lands within the region. In this process it was assumed that national-forest lands comparable in character to unreserved public lands which, though freely open to entry, remain unappropriated would not be taken up even though the national forests did not exist; consequently lands of this type were eliminated from the calculation of potential taxability as were also lands of types or conditions which, where privately owned within the same region, were being allowed to revert to the county for delinquent taxes.

The degree to which lands now reserved for national-forest purposes would be appropriated if opened to entry is difficult of approximation. One perplexing question is afforded by the lands chiefly valuable for grazing purposes. Under open-range conditions, stock growers as a general rule acquire title only to the key lands such as meadows, springs, stream borders, or other strategic points, which so fully control the use of all commingled lands that the holder of the key lands has practically exclusive use without ownership or tax payment. It is impossible accurately to determine how far this practice would prevail if the national forests did not exist. If it were general, the States or counties would derive no tax from the major part of the grazing lands, whereas at present they receive 25 percent of all grazing receipts therefrom.

Another debatable point is the extent to which private owners would appropriate and continue to pay taxes upon lands supporting inferior stands of timber. The national forests contain large areas supporting what is designated as "protective forest" for which no economic demand is probable for many years to come. Grounds exist for honest doubt as to the degree to which this class of timbered land would pass to private ownership if subject to appropriation.

The assumption that owners of timbered lands generally would continue to pay heavy taxes until cutting becomes economically feasible or after the timber is removed is in large measure controverted by the rapidity with which much cut-over and some timbered land with no considerable value for other purposes, such as farming, grazing, etc., is being allowed to revert for taxes in many regions. Growth, yield, and cost studies by the Forest Service indicate that the less productive types of forest land cannot, with current or probable stumpage values, pay appreciable net returns over interest, taxes, and other carrying charges, at the present rate of capital investment, taxation, and protection cost. Attempts to realize an immediate contribution to local governmental costs by taxes disproportionate to income would tend to force much land into a condition of unproductivity. A method of administration which will permit the continued constructive management of the properties and the fullest realization of their wealth-producing capacity is far more logical.

The true criterion of the capacity of any given class of land to contribute to the cost of State or county government is the income producing, or consequent rental or investment value of such land. Experience is demonstrating that long-accepted principles of private ownership of land and timber are in many cases economically fallacious; past payments of taxes upon privately owned lands are no criteria of future payments. The tax returns from privately owned forest lands are continually diminishing as the timber is cut off and serious question is arising in some localities as to whether the present owners of uncut timberland which will not be marketable for a decade or two can afford to carry the costs of its ownership for the further period which must elapse before the timber value profitably can be realized. Upon lands which contain stored up or accumulated natural values, such as timber for which a reasonably early market can be foreseen, the owners will, of course, continue to pay taxes until such time as those values can be completely exploited. Lands held with this object in view temporarily can pay a higher tax than lands held for permanent productivity. But in many forested regions the payment of taxes is discontinued as soon as the accumulated values are removed.

In view of these circumstances it is debatable whether the national-forest lands, considering their character and economic capacity to produce wealth, could under any other form of ownership contribute more to the cost of State and county government than they ultimately will contribute under the existing procedure. At present, the capacity of private ownership to pay prevailing rates of taxation is based primarily upon the existence of accumulated natural wealth created without human effort, acquired, at small expense and temporarily preserved, pending utilization, by minimum expenditures for protection. The national forests, of course, contain comparable stored-up or accumulated natural values, but their importance as sources of future supply, rather than of immediately marketable commodities, justifies larger expenditures than private owners would make to preserve and perpetuate such values; while upon much of the national-forest area the objective and requirement is to create new values. Where such objectives and requirements exist, old rules of taxation conceivably may be inappropriate and inimical. No equitable comparison can be made between the proper contribution to costs of local government by privately-owned lands and by national-forest lands until private lands are placed upon the same basis of permanency in timber production, watershed protection, and other stabilized land uses; nor can an equitable comparison be made without taking into account the fact that the returns from the national forests will progressively increase as their resources become more fully usable and more fully developed.

These common problems aside, some variation existed in working out this phase of the study. Some reporting officers classed as potentially taxable some lands that apparently will not become privately desirable for many years, while others excluded such lands from the taxable category. Some reporting officers included as potentially taxable all lands which might be privately appropriated even for temporary uses—others only the lands of such character as to create the presumption that they would remain permanently in private ownership and taxable if appropriated. Severity of classification in some units is offset by liberality of classification in others. The figures derived may vary as much as 25 percent from the maximum private appropriation which actually might occur were the national forests thrown open to entry.

In estimating the potential taxability of national-forest lands no consideration was given to mineral lands, since such lands are now freely open to appropriation under the general mining laws of the United States and would in no way be affected by the abolition of the national forests. The passing comment may, however, be made that the inclusion of such lands within national forests retains them in a status which permits of their full and free development when otherwise they might have been locked up by appropriations for other purposes.

In compiling statistics as to tax payment on private lands, an effort was made to obtain averages over a period of several years, but where this was not practicable statistics for the last completed tax period were secured. All figures given are for nonurban lands exclusive of improvements. In compiling the figures the plan primarily was to determine the taxes actually paid, but in a majority of cases it was necessary to report instead the taxes as levied by the assessors, which means that the payments shown are greater than those actually collected, since inevitably there would be some delinquency.

In reaching conclusions as to the potential taxability of national-forest lands it is necessary to bear in mind the general difference between such lands and the privately owned taxable properties in the same political unit. With the exception of the lands purchased for national-forest purposes in the Eastern States, the national forests, speaking broadly, are the public lands which remained after an extended period of settlement and appropriation. They are confined largely to the higher elevations of the principal mountain masses of the United States and consequently embrace a great deal of land of low productive value, difficult of accessibility or utilization. It is futile to assume that lands of such character are permanently capable of making substantial contributions to local costs of government whether they are in private or public ownership. This fact necessarily must be taken into account in the consideration of the present subject. With the possible exception of place grants to railroads, States, or other agencies, the privately owned taxpaying lands within national-forest counties normally represent the choicest and most desirable lands, the eagerly acquired, permanently held, and highly developed revenue-productive properties upon which the economic life and industrial prosperity of the unit largely is built. They include the valuable agricultural and grazing lands, the best and most accessible timber, and the lands most highly developed for resort and summer-home purposes. The returns per acre from such lands naturally and properly should be several times the returns per acre which may be expected from lands of the character reserved for national-forest purposes. Yet the disparity is not so great as might be expected. In some cases, the exclusion of a minor acreage of the most valuable lands from the calculations would bring the average tax return from the remainder of the private lands into substantial harmony with the average return from the national-forest land.

In many units, tax-delinquent private lands which make no return whatever to county costs afford opportunity for interesting comparisons with the national-forest lands which do make a substantial return. It was difficult, however, to secure completely dependable figures on tax-delinquent or tax-revested land. In many counties records of tax-delinquent or tax-revested lands, particularly the latter, were poor. At best, the data on tax-delinquent lands are confusing because of repeated purchases at tax sales; and even within a given State the counties do not appear to follow uniformly the procedure of State law, and numerous instances were encountered where counties maintain no record of delinquent land as such. In certain counties, the county officials stated that it would take from 1 to 2 months to make accurate statements of delinquent land by classes. For these reasons, the delinquent land figures compiled in the study necessarily are minimum, since it was quite improbable that any land was improperly included but quite certain that much delinquent land was not included.

Table 4, columns 8, 9, 10, and 11 picture roughly the extent to which the lands now reserved for national-forest purposes might, through taxation, have contributed to the costs of local government if they had not been withdrawn from private appropriation and ownership by reservation or purchase. Emphasis must, however, be laid upon the fact that the figures shown are of historical rather than current or future value. They were compiled in 1927, were intentionally made liberal even under 1927 conditions, and in the form presented are substantially greater than the figures initially developed by the reporting officers.

TABLE 4.—*Study of actual taxability of private lands and potential taxability in States containing national forests* [1]

State	Returns from private land in counties containing national forests				
	Acreage assessed		Average annual tax		
			Total levy	Per acre	Ratio to county income
	Acres	*Percent*			*Percent*
California	39,938,972	46.5	$70,778,510	$1.770	30.6
Oregon	27,011,177	46.7	11,859,340	.439	22.0
Washington	11,486,302	43.4	10,052,234	.875	25.4
Arizona	8,439,358	14.6	1,787,387	.212	11.9
Colorado	13,860,988	31.3	4,817,773	.348	28.5
Nevada	3,504,102	7.6	363,974	.104	14.0
New Mexico	17,064,212	30.4	1,213,625	.071	20.2
Utah	7,179,325	13.9	2,108,919	.294	12.5
Idaho	10,722,247	26.2	4,130,842	.385	23.3
Montana	29,995,534	49.5	4,403,367	.147	21.1
Wyoming	8,005,755	22.4	1,361,427	.170	8.3
South Dakota	5,798,716	69.2	1,213,289	.209	55.0
Nebraska	4,188,467	88.4	241,560	.058	42.8
Michigan	1,419,416	53.0	337,483	.238	56.0
Minnesota	8,257,750	74.1	4,902,530	.594	50.0
Arkansas	[2] 4,040,712	80.2	615,112	.152	40.8
Oklahoma	482,418	62.2	145,958	.303	----------
Alabama	762,472	89.6	104,783	.137	56.3
Florida	3,459,152	82.9	2,443,686	.706	68.8
Georgia	1,111,903	82.8	144,542	.130	42.4
South Carolina	391,615	94.1	58,709	.150	23.4
North Carolina	3,776,425	87.8	1,692,616	.448	29.1
Tennessee	2,137,815	86.5	1,186,160	.555	47.0
Virginia	4,530,065	73.5	1,607,499	.355	30.5
West Virginia	1,743,848	63.8	531,029	.304	34.4
Maine	1,224,738	96.7	453,868	.371	36.1
New Hampshire	2,429,844	84.7	2,632,523	1.083	55.9
Pennsylvania	1,710,348	85.7	519,654	.304	17.1
Total or average	224,673,676	--------	131,708,399	.586	----------

[1] Periods covered by taxation data vary from a single year in some States to average of 2, 3, or 5 years in others.

[2] In only 10 out of 18 counties.

Table 4.—*Study of actual taxability of private lands and potential taxability in States containing national forests*—Continued

State	Land tax delinquent 3 or more years		Potential taxability of national forest lands [3]			
	Area	Amount	Area adapted to private ownership	Probable assessed value if privately owned	Tax yield if privately owned	Return per acre of total national forest area
	Acres		*Acres*			
California	110, 716	(5)	4, 179, 148	$36, 676, 629	$1, 168, 770	$0. 062
Oregon	952, 149	$825, 927	7, 779, 225	48, 424, 703	1, 468, 714	. 111
Washington	615, 014	1, 338, 191	2, 332, 941	24, 728, 639	1, 354, 940	. 141
Arizona	(5)	522, 395	7, 472, 000	20, 365, 680	453, 258	. 040
Colorado	408, 731	157, 328	3, 214, 189	4, 281, 497	395, 953	. 030
Nevada	7, 128	2, 164	91, 272	260, 970	4, 516	. 001
New Mexico	(5)	1, 924, 190	7, 837, 200	9, 054, 450	238, 781	. 028
Utah	198, 526	156, 571	2, 618, 795	9, 341, 228	230, 580	. 031
Idaho	989, 279	615, 763	2, 990, 170	20, 838, 621	668, 536	. 035
Montana	1, 030, 472	1, 193, 139	2, 686, 212	22, 039, 136	341, 580	. 021
Wyoming	216, 814	27, 149	845, 218	4, 945, 505	74, 259	. 009
South Dakota	503, 667	3, 318, 935	281, 890	2, 222, 872	60, 785	. 057
Nebraska	(5)	(5)	205, 946	590, 622	8, 614	. 042
Michigan	295, 312	67, 433	1, 020	21, 506	787	. 006
Minnesota	1, 097, 189	2, 749, 833	63, 000	497, 645	21, 425	. 021
Arkansas	[4] 25, 160	5, 005	858, 588	2, 649, 341	79, 053	. 081
Oklahoma	62, 803	23, 786	56, 480	167, 720	3, 477	. 057
Alabama	(5)	(5)	107, 000	261, 885	5, 722	. 053
Florida	317, 480	108, 811	343, 180	636, 745	35, 595	. 104
Georgia	(5)	(5)	193, 859	523, 678	12, 506	. 065
South Carolina	(5)	(5)	41, 042	49, 045	2, 575	. 063
North Carolina	(5)	(5)	376, 183	1, 537, 671	27, 403	. 073
Tennessee	(5)	(5)	322, 790	920, 631	19, 978	. 062
Virginia	(5)	(5)	574, 286	714, 845	16, 039	. 028
West Virginia	(5)	(5)	225, 318	436, 380	9, 258	. 041
Maine	(5)	(5)	32, 256	165, 701	7, 092	. 220
New Hampshire	(5)	(5)	427, 325	2, 328, 958	65, 078	. 152
Pennsylvania	(5)	(5)	214, 416	846, 149	46, 011	. 215
Total or average	6, 830, 440	13, 036, 620	46, 370, 949	215, 528, 452	6, 821, 285	. 050

[3] Area, value, and tax yield are based on area adapted to private ownership. Yield per acre is figured on total acreage of national forests in States.

[4] Applies to all 18 national forest counties.

[5] Data not available.

Economic facts and trends during the past five years largely have invalidated the 1927 determinations. A true realization of the economic potentialities of such types of wild land markedly has reduced the incentive to convert such lands to private ownership and to assume the attendant obligations of annual tax payments, special assessments, protection costs, interest charges, and other cost items. For example, western livestock growers now realize that ownership of range lands, other than those of highest productivity or greater strategic control, at the prices and subject to the taxes prevailing during the past decade, spells insolvency more frequently than profit. Owners of certain types of forest lands have reached the same conclusions. This fact adequately is confirmed by the tremendous increase in tax delinquency manifest in recent years and discussed in another section of this report. It is further confirmed by the present disinclination to appropriate any appreciable part of the 173 million acres of public lands which remain unreserved and unappropriated. A current study of the degree to which the national-forest lands are adapted to private ownership and management and capable of permanently contributing to costs of local government through annual taxation would yield results far less optimistic than those pictured in table 4. The economic capcity of the less productive lands to yield returns over and above the costs of their own constructive management obviously has certain inherent limitations.

After all lands attractive to private initiative had been appropriated there would still remain large acreages in public ownership, subject to progressive increase as private initiative exploited its lands and allowed them to revert to public ownership through tax delinquency. In some instances these residual lands would form large compact areas susceptible of economical protection and management; in others they would be widely interspersed among private lands and difficult either of protection or management. Collectively they would constitute a public obligation of large proportions. In the circumstances under discussion, this obligation logically would rest upon the State.

Under adequate management these lands normally should produce some revenues, but these would be far below the average returns derivable from the entire national-forest acreage. Generally their productivity would be of the lowest and their utilization most difficult and expensive. Frequently their use would be so completely controlled by intermingled private lands that there could be no competition, hence no need of compensation for their use. In approximating the probable revenues from such lands, consideration must be given to their economic value and the difficulties attendant upon their use. No fixed rule or principle would be generally applicable. The conclusions necessarily must be based upon individual judgment and knowledge but unavoidably must be arbitrary.

In the States of Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, Maine, New Hampshire, and Pennsylvania, all national-forest lands were classed as susceptible to private ownership and used in computing the possible tax return, leaving no residue for which to compute a possible income. In the other States the proportions and income-producing possibilities of the residual lands varied markedly because of the wide differences in the proportions of the lands that theoretically could be privately owned and the kind, quantity, and distribution of those which would remain in public ownership. Residual lands primarily valuable for grazing use might continue to yield relatively high revenues while lands valuable only for the inferior stands of timber thereon would yield little or nothing in the way of cash returns. By the processes indicated and on the basis of average annual returns under national-forest management from 1923 to 1927, the probable returns per acre per annum from the residual lands were worked out as follows:

	Cents		*Cents*
California	2	Montana	1
Oregon	2	Wyoming	2
Washington	1. 5	South Dakota	5
Arizona	1	Nebraska	5. 4
Colorado	1. 4	Michigan	. 5
Nevada	2	Minnesota	1. 5
New Mexico	1	Arkansas	3
Utah	2	Oklahoma	5
Idaho	1. 5		

It is a logical assumption that if all the most productive and valuable lands were privately appropriated the justifiable expenditure per acre of public funds upon the remaining lands necessarily would be much lower than the average expenditures made in the fiscal years 1923–27. On the other hand, the lands remaining in public ownership would be more difficult to protect and manage because of their widespread dispersal among lands not under public control. The conclusion was reached that the probable average cost of protecting, developing, and managing the residual lands would be approximately two thirds of the average actual expenditues per acre on the national forests 1923–27. In the 11 eastern States where all of the land was classified as potentially susceptible of private ownership, with no residue demanding public protection, there would, of course, be no protection costs. In the other States the probable costs per acre of protecting, developing, and managing the residual lands, presupposing the same intensity of protection, development, and management that is given similar types of lands in the national forests, were estimated to be as follows:

	Cents		*Cents*
California	6. 6	Montana	8
Oregon	6. 34	Wyoming	3. 66
Washington	7. 6	South Dakota	7. 75
Arizona	1	Nebraska	13
Colorado	3. 6	Michigan	14
Nevada	1. 4	Minnesota	9. 1
New Mexico	2	Arkansas	12
Utah	3. 1	Oklahoma	20
Idaho	7. 5		

TABLE 5.—*Assumption I—Permanent private ownership and consequent taxation of all suitable lands plus State management and protection of residual public lands* [1]

State	Theoretical returns to States			Theoretical cost of care of public lands	Net loss (−) or gain (+)
	Taxes on private lands	Revenues from public lands	Total		
California	$1, 168, 770	$295, 845	$1, 464, 615	$976, 289	+$488, 326
Oregon	1, 468, 714	109, 181	1, 577, 895	346, 105	+1, 231, 790
Washington	1, 354, 940	109, 179	1, 464, 119	553, 174	+910, 945
Arizona	453, 258	38, 657	491, 915	38, 657	+453, 258
Colorado	395, 953	124, 491	520, 444	358, 533	+161, 911
Nevada	4, 516	86, 446	90, 962	60, 513	+30, 449
New Mexico	238, 781	6, 713	245, 494	13, 427	+323, 067
Utah	230, 580	95, 421	326, 001	147, 902	+178, 099
Idaho	668, 536	241, 502	910, 038	1, 207, 510	−297, 472
Montana	341, 580	132, 334	473, 914	1, 058, 669	−584, 755
Wyoming	74, 259	151, 620	225, 879	277, 464	−51, 585
South Dakota	60, 785	39, 062	99, 847	60, 546	+39, 301
Nebraska	8, 614	11, 121	19, 735	26, 773	−7, 038
Michigan	787	628	1, 415	17, 587	−16, 172
Minnesota	21, 425	14, 071	35, 496	85, 362	−49, 866
Arkansas	79, 053	3, 619	82, 672	14, 478	+68, 194
Oklahoma	3, 477	250	3, 727	1, 000	+2, 727
Alabama	5, 722		5, 722		+5, 722
Florida	35, 595		35, 595		+35, 595
Georgia	12, 506		12, 506		+12, 506
South Carolina	2, 575		2, 575		+2, 575
North Carolina	27, 403		27, 403		+27, 403
Tennessee	19, 978		19, 978		+19, 978
Virginia	16, 039		16, 039		+16, 039
West Virginia	9, 258		9, 258		+9, 258
Maine	7, 092		7, 092		+7, 092
New Hampshire	65, 078		65, 078		+65, 078
Pennsylvania	46, 011		46, 011		+46, 011
Total	6, 821, 285	1, 460, 140	8, 281, 425	5, 243, 989	+3, 037, 436

---

[1] Assumption I is based on figures for Federal fiscal years 1923 to 1927.

As developed by this method of analysis, the indicated financial consequences to the States of a policy of private appropriation, ownership, and protection of all lands attractive to private enterprise, and State protection and management of the unappropriated or revested lands, are shown in table 5. The premises are believed to be valid and conservative. They indicate that if instead of being administered as national forests the lands involved were passed to private ownership to the fullest degree warranted by their inherent values and taxed on the same bases as similar lands in private ownership, and if the lands remaining in public ownership yielded the highest return per acre per annum that probably could be realized, and if the States protected, developed, and managed the lands remaining in public ownership with the same qualitative and quantitative standards as those hitherto applicable to the same lands, 6 of the States would incur annual deficits and 22 of the States would derive net financial returns. In 17 of these States the theoretical net return under this method would be less, in some cases very much less, than the total net returns under national forest management; in the other 5 the net returns under this method would exceed, generally in small degree, the total net assistance under national-forest administration; but in 4 of these States the national-forest lands largely or entirely have been acquired by purchase or exchange with the complete concurrence and cooperation of the State agencies and the superior merit and desirability of national-forest aid is generally recognized and supported. Furthermore, such theoretical net balances of returns over cost as are developed by this method have now become extremely questionable because of the downward trends of wild-land values and the growing tendency for such types of lands to revert to public ownership through tax delinquency.

IF THE NATIONAL FORESTS HAD INSTEAD BEEN ADMINISTERED AS STATE FORESTS

As another contrast to the known measures of aid afforded by the national forests there remains for consideration the subject of the probable consequences to the several States if the national-forest areas, during the fiscal years 1923–27, had instead been administered wholly as State forests, with no contributions from the Federal Government other than the free cession of the public lands involved.

The first question is whether the States would have been willing to administer adequately all of the national-forest area. In numerous cases a national forest is most important to the protection of interests situated in other States, frequently remote from the area under management. Where the immediate and tangible benefits were of small extent and the major benefits accrued to other States, there would be a natural reluctance on the part of the State containing the forest area to tax its own citizens beyond the point of local and definite benefits, so that unless the beneficiary States made up the additional costs under some form of interstate compact or agreement there would be inadequate or no management of the particular forest area. The difficulties of measuring and evaluating the benefits from a specific area derived, respectively, by possibly several States, and of providing by compact or agreement for the sharing of costs in porportion to benefits, seem obvious.

Another question is that of the degree to which any given State would permanently continue to carry the full obligation of forest protection, development, and management of national-forest areas if the greater part of the cost thereof fell upon the taxpayers of the parts of the State most remote from such areas and apparently deriving the least benefit therefrom. In such circumstances it is not wholly improbable that tax-paying majorities might urge sharp limitations of State action.

Still another question is that presented by the large areas of timber-productive lands actually owned by a number of the States or counties and the annually increasing areas reverting to State or county ownership through tax delinquency. States unprepared to assume the entire obligation of forest conservation logically would incline first to take over the areas within which State or county responsibility was most definite and immediate, a course conceivably militating against effective management of what are now national forests.

These circumstances suggest the improbability that complete and fully effective protection, development, and management of what are now national-forest lands could be anticipated or accomplished through the media of State forests unless the net financial results to the several States under that method were more favorable than those obtainable by any other practicable method. The facts available do not indicate that such would be the case. On the contrary, administration of the national-forest areas as State forests, considering each State as an entity, would result in heavier net expenditures of State funds than would be necessitated by either of the other two courses of action discussed herein.

Making allowances for differences in standards of administration and management, past State expenditures for forest and watershed protection on State lands, as known to or understood by the Forest Service, do not appear to demonstrate any inherent capacity on the parts of the States or lesser political divisions thereof to perform such functions at unit costs substantially lower than those incurred by the Federal Government. In few if any instances could adequate protection and management be gained with smaller organizations or fewer field men or men willing to work for appreciably lower rates of pay. Performance by other State agencies of functions relating to forest management or development would no more than offset the extent to which such functions are now performed by other Federal agencies. The conduct by 28 separate States of the forest-research work now in progress on the national forests, collectively would require a greater number of research workers than is necessary to carry out the Federal program of research. Abundant factual data relating to the comparative costs of constructing and maintaining highways, roads, trails, lookouts, telephone lines, administrative structures, and other physical improvements show no basic factors consistently illustrative of the greater economy of State expenditures. On the contrary, it is not wholly improbable that the unit costs of administration would be higher under State management than they were under Federal management.

Nor is there any ground for belief that the revenues which would be derived from what are now national forests would be substantially greater under State or county administration than under Federal administration. Higher returns would be obtainable only by higher charges for resources or privileges, and since such higher charges largely would be borne by local industries and interests, they conceivably might diminish the tax-paying power of the local community. At the present time, no national-forest stumpage is sold in large quantities except at competitive bid and to the highest bidder after full publicity has been given by appropriate advertisement. Livestock growers in the western States frequently allege that increased grazing fees would be a burden on the industry. The occupancy of national-forest lands for commercial, industrial, and recreational purposes is now allowed to the full extent of the public demand, at prices representing fair returns for the privileges enjoyed. No form of State or county administration can be foreseen which would greatly stimulate these revenue-producing activities over and above what they normally will be under national-forest administration, or derive therefrom an annual revenue appreciably in excess of the revenue which will be received under prevailing principles.

In the absence of tenable grounds to the contrary it logically might be contended that if the national forests covered by the 1927 study had been administered as State forests during the fiscal years 1923–27 the net financial costs to the several States would have differed but little from the actual net costs to the Federal Government as shown in the next to the last column of table 1.

However, in recognition of a widely prevalent belief to the contrary and as a means of meeting any existing valid doubts, an analysis has been made on the premise that during the fiscal years 1923–27 the States could have derived revenues 10 percent greater than those received under national-forest auspices, and could have held costs of adequate protection, development, and management to 80 percent of the expenditures actually made. In the States in which the national-forest lands were largely or wholly acquired by cash payment, the States, of course, would have had to pay interest upon such capital investments or would have lost the interest otherwise obtainable by the use of the invested funds. An interest charge of 4.5 percent on the average annual investment during the 5-year period therefore was included in States containing lands acquired by cash purchase.

Table 6 summarizes the average extent to which each of the several States would have derived revenues or incurred deficits if during the fiscal years 1923–27 they had administered as State forests the lands which in that period actually were administered by the Federal Government as national forests but on the premise that revenues would have been 10 percent greater and administrative costs 20 percent lower than they actually were.

TABLE 6.—*Assumption II.—National-forest areas created and administered as State forests during period covered by study, without Federal aid other than free cession of public lands*

State	Annual revenues [1]	Annual costs [2]	Interest charge [3]	Net loss(−) or gain (+)
California	$1,309,256	$1,530,706	------------	−$221,450
Oregon	789,749	1,020,585	------------	−230,836
Washington	464,197	886,256	------------	−422,059
Arizona	339,310	837,866	------------	−498,556
Colorado	455,065	582,220	------------	−127,155
Nevada	110,534	75,821	------------	+34,713
New Mexico	168,723	627,684	------------	−458,961
Utah	230,450	279,385	------------	−48,935
Idaho	675,720	1,744,756	------------	−1,069,036
Montana	296,789	1,527,363	------------	−1,230,574
Wyoming	301,163	373,262	------------	−72,099
South Dakota	123,310	99,801	------------	+23,509
Nebraska	12,177	22,945	------------	−10,768
Michigan	851	16,095	$699	−15,943
Minnesota	34,069	104,154	65,343	−135,428
Arkansas	85,194	123,758	32,183	−70,747
Oklahoma	6,988	14,356	------------	−7,368
Alabama	745	17,753	56,136	−73,144
Florida	27,028	33,917	------------	−6,889
Georgia	10,288	35,420	153,745	−178,877
South Carolina	2,120	5,956	22,648	−26,484
North Carolina	29,403	97,034	303,935	−371,566
Tennessee	15,796	61,840	203,214	−249,258
Virginia	37,477	71,924	273,276	−307,723
West Virginia	4,067	37,232	93,496	−126,661
Maine	2,745	4,400	24,336	−25,991
New Hampshire	34,940	35,924	397,747	−398,731
Pennsylvania	544	42,548	72,304	−114,308
Total	5,568,698	10,310,961	1,699,062	−6,441,325

[1] 110 percent of national-forest receipts.
[2] 80 percent of national-forest costs.
[3] Interest at 4½ percent on actual cash payments for national-forest lands.

This process of analysis demonstrates that of all the 28 States involved only 2 would have derived a net profit through State-forest management of national-forest lands. One of these would have been Nevada where costs of forest protection are low and revenues from grazing use general and relatively high. The other would have been the State of South Dakota where the Black Hills and Harney National Forests afford probably the best current combination of intensive forest management, high productivity, large stumpage values, and active local demand to be found on any national forest. Even in these two States the theoretical net returns derivable through management as State forests would fall far short of the total benefits actually enjoyed during the period through the agency of the national forests. The other 26 States would all have shown annual deficits, some of very large proportions.

GENERAL SUMMATION OF RESULTS OF STUDY

To facilitate comparisons, the net results as shown in tables 2, 5, and 6 are summarized in table 7 and figure 2, in which there also is presented an interpretation of the net financial consequences to the States had the areas under consideration been administered as State forests with approximately the same revenues as those actually derived and the same administrative costs as those actually incurred during the fiscal years 1923–27. The figures submitted are actual or theoretical receipts and expenditures. No attempt is made to evaluate the numerous abstract or intangible benefits which by common consent are recognized as the consequences of sound forest management but are difficult of quantitative expression; nor does table 7 express the values of the actual benefits enjoyed by local land-owners or residents because of national-forest management, as shown in the last column of table 2.

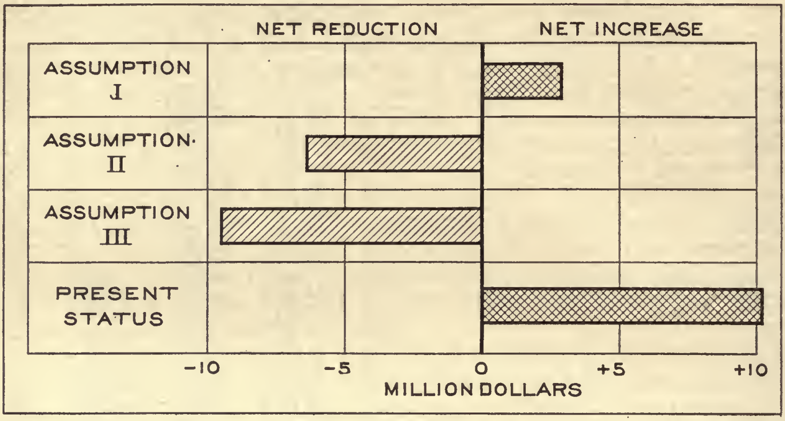

FIGURE 2.—Graphical representation of extent to which State or county resources available for forest conservation would be reduced or increased under different assumptions as to ownership, as shown in table 7.

TABLE 7.—*Estimated net loss or gain under different assumed forms of private and State ownership of national-forest lands compared with actual total net gain to State and counties for period 1923–27*

State	Net loss (−) or gain (+) under assumption [1]	Net loss (−) or gain (+) under assumption [2]	Net loss (−) or gain (+) under assumption [3]	Net gain (+) to States and counties from present Federal ownership [4]
	Dollars	*Dollars*	*Dollars*	*Dollars*
California	+488, 326	−221, 450	−723, 149	+1, 503, 122
Oregon	+1, 231, 790	−230, 836	−557, 778	1, 528, 260
Washington	+910, 945	−422, 059	−685, 823	907, 109
Arizona	+453, 258	−498, 556	−738, 869	701, 207
Colorado	+161, 911	−127, 155	−314, 080	641, 175
Nevada	+30, 449	+34, 713	+5, 709	191, 306
New Mexico	+232, 067	−458, 961	−631, 220	454, 900
Utah	+178, 099	−48, 935	−139, 732	384, 720
Idaho	−297, 472	−1, 069, 036	−1, 566, 654	1, 673, 921
Montana	−584, 755	−1, 230, 574	−1, 639, 396	1, 122, 243
Wyoming	−51, 585	−72, 099	−192, 793	511, 857
South Dakota	+39, 301	+23, 509	−12, 651	108, 010

[1] Assumed private appropriation and ensuing taxation of all present national-forest lands suitable for permanent private management, plus adequate protection and management by States of all national-forest lands remaining or revested in public ownership; returns to States to comprise (*a*) taxes on privately owned lands and (*b*) revenues from residual publicly owned lands.

[2] Assumed that without aid from Federal Government, other than free cession of public lands involved, it had been necessary for States to create and administer as State forests what actually were national forests during the period 1923 to 1927, but conceding that the States could have derived 10 percent more revenue and administered the lands at 20 per cent less cost than the Federal Government.

[3] Assumed that without aid from the Federal Government, other than free cession of public lands involved, it had been necessary for States to create and administer as State forests what actually were national forests during the period 1923 to 1927; the revenues derived and the costs of administration being identical with the receipts and expenditures under Federal management.

[4] Actual total direct contributions to State or county revenues or development programs derived from or by reason of the national forests during the fiscal years 1923 to 1927.

TABLE 7.—*Estimated net loss or gain under different assumed forms of private and State ownership of national-forest lands compared with actual total net gain to State and counties for period 1923–27*—Continued

State	Net loss (−) or gain (+) under assumption	Net loss (−) or gain (+) under assumption	Net loss (−) or gain (+) under assumption	Net gain (+) to States and counties from present Federal ownership
	Dollars	*Dollars*	*Dollars*	*Dollars*
Nebraska	−7, 038	−10, 768	−17, 611	14, 511
Michigan	−16, 172	−15, 943	−20, 045	2, 056
Minnesota	−49, 866	−135, 428	−164, 563	80, 493
Arkansas	+68, 194	−70, 747	−109, 431	87, 922
Oklahoma	+2, 727	−7, 368	−11, 593	10, 405
Alabama	+5, 722	−73, 144	−77, 650	8, 207
Florida	+35, 595	−6, 889	−17, 825	30, 642
Georgia	+12, 506	−178, 877	−188, 667	16, 292
South Carolina	+2, 575	−26, 484	−28, 165	3, 987
North Carolina	+27, 403	−371, 566	−398, 498	87, 923
Tennessee	+19, 978	−249, 258	−266, 154	34, 638
Virginia	+16, 039	−307, 723	−329, 111	64, 044
West Virginia	+9, 258	−126, 661	−136, 339	20, 293
Maine	+7, 092	−25, 991	−27, 341	4, 056
New Hampshire	+65, 078	−398, 731	−410, 888	42, 410
Pennsylvania	+46, 011	−114, 308	−124, 994	9, 685
Net gain or loss	+3, 037, 436	−6, 441, 325	−9, 525, 311	+10, 245, 394

Table 7 leads inevitably to the conclusion that acting through the central agency of the Federal Government the people of the United States have very definitely and largely assisted each of the States containing national forests to work toward an adequate program of forest conservation within its borders more effectively than would have been possible if the entire burden of forest protection had rested upon the State and its component units of government. It is true that the national-forest system was established in recognition of a national need, as a measure of national security and welfare, rather than with the studied purpose of assuming part of the State's function or obligation in the field of forest conservation; nevertheless, the national policy markedly has aided the States to meet the inescapable requirements of economic and social necessity created by dangerous trends in forest-land utilization. No other use to which the national-forest lands might have been devoted, no other principle or method under which they might have been administered, would as fully or effectively have enabled the States to meet the tremendous problem which confronted them. There would have been no greater economic and social use and enjoyment of the lands and natural resources comprising the national forests than that which has been allowed under Federal management. There could have been no other way by which greater financial resources could have been made available for purposes of forest protection, regeneration, and management with less tax burden on the properties and citizens of the States and counties in which the national forests are situated. Neither could there have been any fairer or more equitable way by which both the common and collective interests of all the people of the United States, as represented in assured future supplies of timber and adequately protected watersheds, and the more localized interests of the States and their citizens, could be harmoniously correlated and coordinated. The record shows no injustice or inequity to either party to the compact; on the contrary it seems conclusively to demonstrate that, while the States through their concurrence and cooperation in the development of the national-forest system have made it possible for the Nation as an entity to safeguard the future interests and welfare of all its citizens, the Nation in its turn has made it possible for the States containing national forests to accomplish more within their own fields of forest conservation and management than otherwise would have been possible.

FEDERAL AID IN ORGANIZING FOREST CREDIT FACILITIES

By BURT P. KIRKLAND, Principal Forest Economist

THE PURPOSES TO BE SERVED

It is common knowledge that speculative capital is seldom lacking for investment in matured stands of timber. Very largely as a phenomenon connected with the liquidation of speculative forest investments, an excess of capital has flowed to the support of logging and sawmilling operations. These have been relied on as the most effective means of liquidating timber investments, especially if no effort is made to balance production or avoid waste. In making these investments little attention has been paid to the possibility of integrating different wood-using industries in numerous localities without the use of additional capital. It can hardly be maintained, however, that any form of wood utilization has suffered in the aggregate for lack of capital, although the capital has not always flowed to the plant locations economically most desirable. On the whole, capital investment has been directed to the purpose of utilizing existing timber supplies like a store of minerals. It has been so managed as to destroy rather than to preserve the forest resource.

This discussion deals with the problem of supplying capital for continuous forest production. In the section of this report entitled "Status and Opportunities of Private Forestry," it was brought out that a relatively small portion of the existing capital investment in forests is being directed toward sustained-yield operation. To insure continued forest productivity new objectives need to be set up in the management of this capital. New capital investments in extensive forest areas will be needed before growth can be restored to satisfactory levels. It seems apparent that credit capital, obtained on terms appropriate to this type of enterprise, could materially facilitate placing the remaining forests on a continuous-yield basis.

NATURE OF INVESTMENT IN FOREST ENTERPRISES: THE PRESENT INVESTMENTS

As was stated in the section of this report dealing with the status and opportunities of private forestry, 80 to 95 percent of the investment in producing forests is represented by the growing stock and soil, which economists dealing with the factors of production call "land" or "natural resources." Business men include these elements under the term "capital," and from the business standpoint do not distinguish them from capital such as is represented by the forest improvements created by labor or the investment of money. In this discussion the term "capital" will be used in this inclusive sense.

When the first white settlers landed within the territory now included in the United States there were in this territory some 800 million acres of forests stocked for the most part with trees of magnificent size. At that time, however, these forests had no capital value. Now their remnants have a large capital value. This capital value essentially results from the relationship between human needs and the forest resource and from the right of ownership, which enables the owner to reap profit from the sale of forest products. Very little of the present capital value of American forests has been created by labor or by the investment of money. The money value of property rights in private forests has grown through "unearned increment" as they were handed from generation to generation. The value status at any given time has been recognized as the titles were transferred from owner to owner. This process of valuating forests has been active in one region after another. The South and the West are the last regions in which prices for timberlands have reached high levels.

It is not to be assumed either that this process has come to an end or that it cannot be reversed. Certainly some reversal, that is to say decline in value, has recently taken place owing to deflation of prices and depletion of growing stock. Future movements of value will depend on the treatment the forests receive. Widespread cutting operations now going on without care for future production are removing forest capital too rapidly to permit replacement by growth unless the forests are rigidly protected from fire and other destructive agencies. Maintenance of capital value during the past 30 years or more, since timber cut has exceeded growth, has depended on writing up values of the stumpage remaining.

Changes in value reflected in such "write-ups" may occur suddenly. After the World War, price and credit inflation brought about increases through a period of nearly 5 years except during the short depression of 1921. Such changes are seldom of any lasting benefit and often bring disastrous after effects. An oversupply of unduly cheap credit might produce similar results. General adoption of improved machinery may increase profits and thus capital values, but its effect is more likely to be dissipated in lower prices to consumers. Skilled management, since it is a scarce factor of production, leads to increased valuation of the properties benefiting by it. The commonest device of skilled management is to adopt improved machinery, improved technique, and the results of research in advance of the industry as a whole.

When the term "capital" is considered as inclusive of these capitalized resource values it becomes clear that organization of forestry as a business involves long-term investments and, if credit capital is used, long-term credit. The capital structure of the enterprise, including both ownership capital and credit capital, should be such that pressure for liquidation or withdrawal of capital will be avoided. For the larger enterprises the device that has been worked out, but not altogether perfected, to serve this purpose is the corporation. By means of the corporation the individual investment has in a considerable proportion of business investments become liquid although the enterprises are permanent. One of the chief elements which often interfere with the permanence of corporate enterprise is the relation of the credit capital to the enterprise as a whole. Permanence depends on limiting the creidt capital in amount, limiting interest rates to a point not in excess or not much in excess of the earnings of the capital, and providing means for gradual amortization. These three factors require careful consideration.

The total investment in privately owned forest lands and timber has been calculated as of the year 1929 by the Forest Taxation Inquiry of the United States Forest Service to be approximately $4,075,000,000. This is less than previous estimates of these values, which is readily accounted for by the fact that in the past few years the progress of forest depletion has exceeded the rate at which capital values have been "written up."

FURTHER INVESTMENTS INVOLVED IN BUILDING UP FOREST PROPERTIES

As is shown in other sections of this report, in most regions of the United States the forests have been largely depleted of growing stock; in other words, the forest capital has been liquidated. On large areas this process may have gone too far to permit restoration under private management. This discussion refers chiefly to private forest enterprises on areas that still contain saw-timber or cordwood growing stock or to recently cut-over areas closely associated with saw-timber or cordwood areas.

In most instances forest capital can be built up by establishing conditions under which nature will provide the necessary increased stocking through growth. The safest way to build up capital is through utilizing income from products sold currently. The problem of obtaining sufficient gross income to carry the property and maintain the owner while the growing stock is being built is simplified if high-grade mature timber is present in considerable volume. Where the growing stock is badly deteriorated but a market for low-grade material exists, it may still be possible by skilled management to obtain sufficient income from sales to meet expenses during the time required to rehabilitate the growing stock. On numerous properties money investments will be necessary to pay taxes and the costs of administration and fire protection and permit the owners to forego income from the forest while it is being rebuilt to a condition that will permit continuous operation. This refers to properties occupied largely by young stands too immature for immediate cuttings.

Equally, as urgent as the situations described in the foregoing, if not more so, are conditions found in regions where a temporary surplus of mature timber still remains, specifically in the Pacific coast and north Rocky Mountain regions. Here financial pressure and other influences are leading to hasty and wasteful liquidation of the forests. Credit at economical costs appears fundamental to any program looking to the orderly marketing of the surplus of mature timber under private management in a way to preserve the productivity of those forests on a sustained-yield basis. In any given case, such credits should be extended for the full length of time necessary to accomplish the purpose, with proper rates of amortization as well as of interest. Financial support of this type should assist in diminishing the severity of destructive competition between those now marketing this mature timber without regard to future productivity of the forests and those endeavoring to develop permanent forest enterprises.

There is no adequate basis for estimating with any precision what additions to capital value can be expected as a result of restoration of the growing stock through conservative forest management or what portions of the capital required for this restoration must be borrowed. The enormous losses through growing-stock depletion, the loss of forest improvements, and other features of timber cutting under the liquidation policy add huge sums to the current operating expenses of the industry. The increase in net earnings that will result from saving these losses, under normal conditions of price and of operating costs, will be reflected in capital value. Weighing such information as is available on the present condition of the forest capital with the conditions that must be brought about if the Nation is to continue to be served with forest products warrants the belief that the forests now in private ownership need and reasonably warrant rebuilding to double or more the present capital values.

In addition to enabling present owners of forest land to restore the productivity of their holdings, credit capital would almost certainly have a still larger function in assisting in a redistribution of ownership that would bring more forest land into the hands of enterprisers with the desire and the ability to create permanently productive operating units.

Notwithstanding the desirability of facilitating better management of forests by making credit capital available at reasonable costs, caution should be observed in these credit transactions. An excessive flow of low-interest capital to this field would assuredly result in unjustifiable writing up of capital values. This may be socially undesirable owing to the tendency to divert an undue share of the product of industry to fixed charges at the expense of labor and management.

SOURCES OF PRESENT CAPITAL AND COSTS OF CREDIT CAPITAL

As has already been stated, the principal source of capital in forests (including resource value) has been the gradual process of valuation of the forest resource. The form which title to the capital takes, and the distribution of title, are of importance. Unfortunately, complete information does not exist as to the proportions of capital represented by direct property ownership and by long-term and short-term credit. The most definite information available on any region was obtained by the West Coast Lumbermen's Association in 1931.[1] These data show that the investment value of the lumber industry within the Douglas fir region is approximately $838,761,149, of which $502,674,500 is attributed to timber and the remainder to manufacturing plants. No figures are given for the pulp and paper and other important forest industries of the region. The capital involved is represented by direct ownership to the extent of about 75 percent. The form and times of maturity of the debt represented by the remainder are not given.

It is known that no great amount of capital has been available for long-term loans in the form of timber bonds and that the maturities of such bonds are too early to permit amortization of the loan except through liquidating the stumpage pledged as security. A great deal of the borrowed capital, although invested in permanent form, has come from commercial banks. Since many of these loans lack liquidity they are not altogether adapted to the requirements of commercial banking. Interest rates for loans to be used in timber operations are generally 6 or 7 percent plus financing charges. Since timber operations are often the leading enterprises in their communities they have generally had access to bank credit, often on very easy terms.

---

[1] Greeley, W. B., The Northwest Lumber Crisis. American Forests, September 1931, pp. 529–533.

While borrowed capital has undoubtedly been costly in some instances, the chief difficulties that arise from the present forms of borrowing have to do with the frequent renewals, refinancing, and general uncertainty with regard to permanence of the sources of credit capital.

Equally reliable information is not available for other regions. Income statistics of the Bureau of Internal Revenue [2] show that during the year 1929 corporations engaged in the lumber and woods-products industries paid $18,049,813 and the pulp and paper industries $17,260,075 in interest charges. These amounts were 1.56 percent of the gross receipts of the lumber and woods-products corporations and 1.86 percent of the gross receipts of the pulp and paper industries, respectively. In comparison, the average interest charge of all manufacturing industries was 0.98 percent of gross receipts. The greater part of the forest-products manufacturing is carried on by corporations, but less than half the privately owned forests that are still productive are owned by corporations. No data are available on the credit capital used by individual owners of woodlands or of small sawmill plants.

It is known, however, that throughout the forested regions farm woodlands form part of the security for farm-mortgage indebtedness. The size of the interest bill for corporate forest industries taken together with what is known of farm-mortgage practices in woodland regions leaves little doubt that the total borrowed capital in the forest industries, including forest land and timber holdings, in the United States approaches $1,000,000,000.

It is desirable to reiterate that this borrowing and the resulting interest charges have been for manufacturing purposes rather than for care and perpetuation of forest productivity. The latter purpose is not adequately cared for in the present financial provisions within the forest industries.

ORGANIZED METHODS OF PROVIDING BASIC CAPITAL

In the modern world individual dealings between borrowers and lenders do not meet the needs of industry. Not only are the sums commanded by individuals too small to meet requirements but the undistributed risk to investors is too great. To provide for the flow of capital to the points where it will have the greatest utility and be invested with the least risk has become an institutional problem. Institutional development to meet such needs is by no means complete In late years a strong tendency has manifested itself toward the development of lending institutions adapted to special requirements. Many examples such as insurance companies, mutual-savings banks.

---

[2] Statistics of Income for 1929, pp. 268–284.

and building and loan associations come readily to mind. These have been developed chiefly to serve the needs of persons wishing to save and lend capital, although the building and loan associations originally had an equal aim of serving borrowers. Of more recent development are institutions organized specifically to serve needs of borrowers. These include smaller institutions such as credit unions, but the more outstanding examples are the Federal land banks, the intermediate credit banks, and the home loan banks. To be successful all such institutions must provide a very high degree of security to the funds of lenders.

Whether organized primarily to serve lenders or borrowers, all these institutions require the exercise of the age-old governmental function of protecting the average individual against the encroachments of thievery and dishonesty. These encroachments, which in a simpler society took the form of direct assaults on individuals for the purpose of wrongful appropriation of private property, now take the more subtle and far more effective form of financial manipulation. To prevent losses from this cause as well as from misappropriation of funds by persons in positions of trust, and to reduce losses from incompetent management to a minimum, it has increasingly become a duty of Government to supervise all sorts of banking and financial institutions.

In connection with efforts to accomplish the above ends it has been learned that correct methods of organization and operation result in economy and that mass borrowing on sound lines tends to provide credit capital at lower cost to industry. The Federal land banks have been reasonably successful in attaining these objectives, greatly reducing interest rates on farm mortgages in localities remote from centers where investment funds are plentiful. No Federal land bank bonds have been defaulted.

An institution to serve borrowers should be organized and operated in such a way as to (1) limit safely the amount of credit capital used by the borrower, (2) provide an interest rate within or not much beyond the earning capacity of the enterprise, and (3) provide a rate of amortization the enterprise can meet without the added expense incident to refinancing.

LIMITING THE AMOUNT OF CREDIT CAPITAL USED

It is a frequent practice to provide credit capital to the extent of 50 to 60 percent of the total capital required in an enterprise. By various subterfuges even these limits are exceeded. No doubt circumstances occasionally arise in which the use of credit to this extent is justified, especially if means for rapid amortization of the excess percentage are available. Events of recent years have made it plain, however, that the use of credit capital to these percentages is attended by risks of loss of the physical property by the borrower and loss of investment funds by the lender. If the financial needs of an entire industry are to be served, with full consideration for stability of the credit capital throughout the business cycle, the limit of credit capital should as a regular practice be fixed far below 50 percent.

One of the fundamental reasons for limiting permanent credit capital lies in the changes constantly taking place in capitalized value.

Farm values serve as a good illustration. Census statistics[3] show that the values of farm land and buildings in different years were as follows:

1920	$66, 316, 002, 602
1930	47, 879, 838, 358

It is by no means improbable that value shrinkages were even greater than reported and that the aggregate value at the present time is still lower. By 1931 farm debt had risen to between $13,000,000,000 and $14,000,000,000, with interest averaging 6 percent on mortgage debt, 8 percent on short-term credit, and 15 to 20 percent on merchant credit.[4] The total annual interest charge approximated $900,000,000. In 1930 the gross income of agriculture, including the value both of commodities sold and of commodities consumed on farms, was $9,401,939,000.[5] Interest charges in 1930 were therefore about 9½ percent of gross income. Since income has continued to shrink, interest charges constitute an increasing percentage of gross income. Railroads supply another example of heavy indebtedness that has carried serious difficulties. Consideration of these examples warrants the conclusion that in undertaking to serve the needs of forest enterprises organized for continuous yield the use of permanent credit in excess of 30 percent of the total capital in any individual enterprise should be discouraged. Temporary credit in excess of this percentage will frequently be necessary in the process of assembling and organizing such properties.

INTEREST RATES AS RELATED TO EARNING CAPACITY

When interest rates are paid by an enterpriser in excess of the earnings of his project the lender receives the earnings of his own capital plus part or all ofthe earnings of the borrower's capital, or the surplus rate may be absorbed by costs of placing and administering the loan or by risks on that class of loans. A leading function of credit organization is to reduce costs of placement and administration of loans and to distribute risks. As a result of efficient organization the borrower should be required to pay no more than necessary for the use of the credit with minimum costs incident to carrying the risks and to administration and financing, and the lender seeking safety for his capital should receive an approximation to the riskless rate. The chief factors to be considered are the adequacy of business volume to distribute overhead costs and risks, the building up of reserve to insure meeting unusual risk, and loaning on an amortization plan to avoid frequent refinancing charges. Limitation of loan percentages together with systematic amortization underlies the elimination of risk.

When all possible has been done by these means to establish low interest rates, comparison may be made between the interest rates and the prospective earning rate of the enterprise. The available means for supplying credit capital at still lower rates are virtually limited to the use of tax-collected public funds or of funds raised on securities with endorsement of the Federal Treasury. These means should be used only if the public interests involved demand such action.

---

[3] Bureau of the Census. Fifteenth Census of the United States, 1930. Vol. II, Agriculture, Table 1.
[4] United States Department of Agriculture Yearbook, 1932, p. 501.
[5] United States Department of Agriculture Yearbook, 1932, p. 890.

AMORTIZATION RATES

A rate of amortization that permits discharge of the loan from earnings of the mortgaged enterprise saves refinancing charges and provides a painless method of paying the loan. A loan obtained under these conditions also protects the borrower from the grave risks attending efforts to renew loans in times of depression or panic, and protects the lender against shrinkage in asset value from the same cause. A long amortization period is justified if the loan does not exceed a very conservative percentage of appraisal value, the enterprise is in a field of permanent utility, and the interest rate is as low as or lower than the earnings of the enterprise. It is certainly true that many forest properties meet these specifications. With an interest rate of 5 percent, amortization at one half percent will retire a loan in slightly less than 50 years. A retirement period of 30 to 50 years seems appropriate for basic credit not exceeding 30 percent of the appraised value of the real property. Junior financing beyond the 30 percent should be amortized within 10 years, or subjected to renewals at the time of which the status of the loan can be reexamined.

RELATIONSHIP OF FOREST LOANS TO AIMS OF FEDERAL LAND BANK SYSTEM

A fundamental aim of the Federal land bank system is to promote effective use, in the public interest, of the agricultural land resources of the country and to promote satisfactory social conditions. Effective use of forest lands must be considered closely related to this purpose. For this reason it appears desirable to utilize the existing machinery of the Federal land bank system for handling forest loans rather than to create an entirely new agency. A further important element in this relationship is the fact that much submarginal agricultural land may be diverted to forest use. Facilitating the use of such land for forestry purposes is expected to strengthen agriculture and presumably the security behind farm loans. It appears unwise to impose the function of making forest loans on the present land banks, however, for the reason that these deal with land values chiefly under restrictions that are inapplicable to forest loans. Forest loans will require special types of appraisal and will require supervision of a different technical nature. Therefore, it seems reasonable that the function of providing forest credit should be placed in separately organized institutions.

OUTLINE OF SUGGESTED ORGANIZATION FOR FOREST LOANS

The following is suggested as a possible basis for organizing institutions to provide forest credit:

1. The institutions should be under the control of the Federal Farm Loan Board. This would keep supervising expense at a minimum and insure experienced and competent administration.
2. Not more than four adequately capitalized banks (possibly with $25,000,000 capital stock each) should be created. This would be

a more liberal capitalization by share capital than is provided for the home loan banks or Federal land banks. It would provide a greater margin of safety for bonds issued and greater facility for building up and protecting adequate reserves.

3. Each bank should have a board of directors of seven members. These would be in part elected by the stockholders and in part appointed by the Federal Farm Loan Board,[6] as in the case of the Federal land banks.

4. Suitable central organization of the several banks should be provided to permit cooperative action and mutual aid, including issuance of bonds and debentures under joint liability of all banks.

5. Each borrower should be required to purchase stock in his regional bank to the extent of 5 percent of his loan. Simultaneously he should sign an assignable option for the sale of the stock at par value without restriction on the time of such sale. When in the course of time all the stock of any bank had been taken up, options on the oldest stock outstanding should be utilized to transfer the stock to the current borrowers. Stock should be transferable to a purchaser of the forest property involved, and might be made transferable without restriction after the loan it accompanied had been paid.

6. Banks might begin doing business when 40 percent of the capital was paid in. The United States Treasury would be directed to purchase stock to this extent.

7. Dividends on stock should be limited to 5 percent cumulative. Dividends paid in any year should not exceed the earnings of that year after suitable transfers to reserve accounts.

8. Banks should have authority to issue long-term bonds based on mortgage loans as collateral and with joint liability of the banks. In order to take advantage of conditions under which short-term obligations sell at lower interest rates, authority should be granted to issue short-term debentures not to exceed a reasonable percentage of the paid-in capital, with due regard to current income from interest and amortization of outstanding loans.

9. Banks should be authorized to make first-mortgage loans only on forest properties organized for operation on a sustained-yield basis or being subjected to measures necessary to prepare for such operation. Suitable penalties should be provided for violation of these provisions. No loan or loans to a single concern should exceed 10 percent of the paid-in capital of the issuing bank, "single concern" being interpreted to include with a parent corporation all subsidiary corporations or corporations with interlocking directorates. No loan should exceed 30 percent of the appraised value of the property. Net income should be duly taken into consideration in appraisals. Interest rates should not exceed by more than 2 percent the rate borne by the last previous issue of long-term forest loan bonds. First-mortgage loans should provide for amortization within 30 to 50 years. If made within 5 years, payment should be 1 percent above par to cover costs incident to placing the loan.

10. Where bank officials consider such action desirable, second-mortgage loans might be granted on properties on which the bank holds the first mortgage. Such loans should not exceed an additional

---

[6] Fifteenth Annual Report, p. 62

30 percent of the value of the property, nor should all such loans placed aggregate more than 25 percent of the forest mortgage loans outstanding. Interest rates on second-mortgage loans might exceed the rate on the last sale of long-term bonds by 3 percent. Amortization within 10 years should be required.

The purposes for which loans might be granted would include the following:

1. Such measures as are designed to improve the productivity of organized forest properties, including restricting cut to permit building up growing stock, fire protection, and necessary silvicultural measures. (When loans are made for these purposes on immature forests or on forests the cutting of which should for any reason be deferred, arrangements may be made to advance the loans in annual installments over periods as long as 20 years. No annual installment should exceed the amount required to meet costs for that year.)
2. To assist in the orderly marketing of timber already mature or, in exceptional cases, to withhold from the market timberlands which it would be economically injurious to throw on an overburdened market.
3. To assist in acquiring tracts and assembling them into units of economic size and location for continuous-yield operations.
4. To assist in constructing permanent transportation systems within the confines of forest properties concerned and to connect them with common-carrier transportation facilities.
5. In exceptional cases, to assist in acquiring, rebuilding, or constructing manufacturing plants necessary for complete and economical utilization of forest raw material from the property concerned, including such facilities cooperatively owned by owners of adjacent holdings. No loan should be granted to provide manufacturing capacity that, combined with the capacity of efficient plants existing in the locality, would be excessive in proportion to the present or soon expected sustained yield of the forests of the locality. Judgment on this element should be based on reports of competent technicians.

RECOMMENDATION

In view of important pending changes in the commercial banking systems and possibly in other financial institutions within the supervisory field of the Federal Government, and in view of the desirability of thoroughly examining the operating methods of institutions with similar purposes in order to utilize their experience to the utmost, it is recommended that a study looking to the establishment of an organization such as is outlined above be undertaken cooperatively by the Forest Service and the Federal Farm Loan Board, to be completed at the earliest practicable date.

NOTE.—The foregoing discussion has been reviewed by Paul Bestor, Farm Loan Commissioner, John H. Guill, member of the Farm Loan Board, and A. F. Cardon, chief appraiser of the Federal Farm Loan Bureau.

OTHER FEDERAL FOREST ACTIVITIES AS FORMS OF STATE AID

FOREST PATHOLOGY

By Carl Hartley and J. S. Boyce, Office of Forest Pathology, Bureau of Plant Industry

PAST AND PRESENT AID TO STATES

In a sense, all of the Federal research activity in the forest disease field has been an aid to States, local governmental units, and private-timber owners. Even when the studies were made primarily for control of diseases on the national forests, the published results have been generally available, and unpublished information has been made freely available to State and local officers and private landowners. The total annual cost of this research based on Federal appropriations for the fiscal year ending June 30, 1933, is approximately $133,000 not including funds primarily for diseases of ornamental trees and shrubs. Of this amount, $113,000 is for forest diseases and $20,000 for study of fungous injury to forest products. In some cases the investigations have been made in close cooperation with State agricultural experiment stations or State foresters, part or all of the salary or expenses of former State employees having been carried on Federal funds during studies of local aspects of more general problems. Advice on diagnosis and practical control measures has been given by personal visits when possible.

In no case has there been any grant of Federal funds to State or private agencies for use in connection with control of forest diseases. There are annual Federal grants to the State agricultural experiment stations under the Hatch, Adams, and Purnell Acts for research on agricultural problems; these acts are interpreted as providing for research covering problems of forestry, where such problems are a part of the farm problems or practice of agriculture, or when the investigation is aimed at questions of fundamental science the solution of which will be useful in the general field of agriculture.

An inconspicuous but tremendously important service to all of the States, that is and can be rendered only by the Federal Government, is in the inspection and quarantine activities connected with the prevention of the introduction of new diseases from abroad. The Bureau of Plant Quarantine of the Department of Agriculture, under authority of Federal legislation, forbids the general importation of nursery stock and certain other kinds of material that are known to be likely to carry dangerous parasites, maintains a force of port inspectors to enforce these regulations, and arranges for inspection or long-time observation in quarantine when introduction of foreign propagating stock is essential to American plant breeders or propagators. The amount expended for forest protection by this method cannot be segregated from that spent for the protection of other kinds of plants, since the same personnel attends to all kinds of material. The results of this work are impossible of quantitative evaluation, since we have no way of telling what additional introduced diseases might have entered the country had it not been for this service, or what they might have caused. Had the present regulations and enforcement service been in force 40 years earlier, the loss of our chestnut and the expenditures for blister-rust control might have been postponed for centuries. Some parasites may slip through the most rigidly maintained quarantine, but the hazard is very greatly reduced by such service as the Bureau of Plant Quarantine is giving. State inspection authorities can effectively supplement and strengthen this Federal protection service against foreign pests, but they suffer legal disabilities in excluding foreign shipments which make Federal help necessary. Individual States are also handicapped in preventing the spread of an introduced parasite that is already established in some part of the country. For example, State A may refuse or neglect to quarantine against a disease from another region dangerous to adjacent State B, but which if introduced into A will spread naturally into B. Federal interstate quarantines have also been an important part of the effort to delay the spread of the blister rust within the United States.

The most direct efforts to aid the States in the control of a forest disease have been in connection with the white pine blister rust. The Federal Government initiated the control campaign against this disease; it furnishes each cooperating State with one or more men who act as control leaders under the administrative direction of the proper State official (usually the State forester), to furnish technical supervision of control work, perform necessary experiments to improve control practice, scout for blister rust, and disseminate technical information on the disease and its control. Each cooperating State furnishes men directly to supervise the control jobs lined up by the State control leader, gives administrative direction to all control work, and, when necessary, reimburses owners for the loss of productive currant and gooseberry bushes destroyed in control application. Each owner desiring to protect his pines from blister rust furnishes the labor to pull the wild and cultivated currant and gooseberry bushes growing within 900 feet of the pines, under the direction of a foreman furnished by the State.

The acreage cleared of currant and gooseberry bushes in the United States from 1916 to 1932, inclusive, totals approximately 10,600,000 acres, consisting of 9,077,271 acres of complete initial control work, 934, 329 acres given a second working to maintain control, and 674,756 acres of incomplete initial control work (concentrations of currants destroyed with chemicals on 7 percent of this land, along streams). This work has resulted in completely protecting approximately 6,000,000 acres of white-pine forest, with partial protection to such pine as may be present on the additional 3,700,000 acres in the protection zones and along stream bottoms from which the currants were cleared. The total cost of all control work to the end of 1932 (Federal State, and private expenditures) amounts to $8,307,000, or 83 cents per acre for the area actually cleared of currant and gooseberry bushes.

On the basis of 6,000,000 acres of protected pine, the cost averages $1.39 per acre of pine land. Of the latter amount, 24 cents (17 percent) was Federal funds for development of control methods and for general service activities such as scouting and quarantine enforcement; 55 cents (40 percent) was Federal funds for direct cooperation with the agencies applying control; 55 cents (40 percent) was expended by State agencies and pine owners in control application; and 5 cents (3 percent) was expended for control by the National Forest Service and National Park Service.

The blister rust problem is essentially national in scope. The fact that the Federal Government assumes leadership in cooperating with the States has given them the necessary urge to carry on with this work under a systematic program which has accomplished effective, large-scale control results. Without Federal leadership it is doubtful if the States could carry on any extended program. In addition to giving impetus to the work, leadership has been furnished which results in coordination of effort between the agencies concerned in the work, and in the development of a greater appreciation of the value of forest care on the part of timber owners. Also this leadership has resulted in better coordination of effort between States and has furnished a medium for exchange of ideas which has been helpful to the State organizations in meeting their forestry problems. The same type of organization which has proved effective in securing control of blister rust could be adapted to a much wider field in securing application of the results of investigations in forest pathology.

FUTURE AID TO STATES

The Federal Government must continue to bear much of the expense of investigating forest tree diseases to determine principles for their control. This is indirect aid which is properly a Federal function since many forest diseases, just as forest trees, are regional in their distribution. Rather than direct financial aid to the States for disease investigation, the Federal Government under the provisions of the McSweeney-McNary Act proposes to make its contribution to the solution of problems of more than local concern through pathologists at its regional forest experiment stations. Federal aid cannot and should not be expected to make unnecessary the investigation by the States of their own pathological problems either independently or in cooperation with the regional station.

Great improvement in the utilization of research results could be obtained by the development of field service men, of the type already employed in the white pine blister-rust control work, and where practicable with similar State cooperation, to help in the development by landowners and lumbermen of control work against native diseases.

Quarantine must be maintained by the Federal Government to prevent as far as possible the introduction of diseased or potentially diseased trees from foreign countries or from one region to another within the United States. For the reasons earlier indicated, individual States cannot protect themselves adequately by their own quarantine. Quarantines are a more important part of the program for protection against foreign tree diseases than they are against diseases of most crop plants, since it requires an infinitely longer time to develop a resistant tree by crossbreeding or selection than is needed to develop a resistant annual plant.

Because of the national character of the interests at stake, the Federal Government may need to give direct financial as well as technical aid to State or private owners in the location and eradication of new introduced diseases. Aid is extended to the States for planting trees, and protection against fires; it should also include protection from destructive epidemics. A disease first appearing in one State may be of no importance there because of the limited commercial value of the tree attacked, or unfavorable conditions for the development of the disease, but if allowed to continue unchecked it could easily prove catastrophic in another forest region embracing several States. Naturally taxpayers in one State are reluctant to have money spent for the protection of other States, since there is no assurance that they will receive equal consideration under similar circumstances. The only way action can be taken promptly enough in such situations to be successful is by direct Federal aid, both financial and through leadership which coordinates the efforts of all agencies concerned. The service organization which has proved valuable in curtailing white pine blister rust can be modified to take care of similar situations which additional introduced disease might call into being.

FOREST ENTOMOLOGY

By Division of Forest Insects, Bureau of Entomology

The control of forest insects as a factor in timber production has been developed chiefly by the Federal Government. Each of its three elements—prevention, early detection, and suppression of insect attacks—is dependent upon research for the perfection of its methods. The highly technical nature of the subject, its importance, and its scope and complexity call for the utmost possible Nation-wide coordination of plans, funds, and personnel and therefore, for unified Federal and coordinated State action.

The work in forest insect control has grown up around the activities of the Bureau of Entomology, which has handled the research activities, recommended plans and procedure for putting research results into practice, and to a considerable extent supervised the control work. Control measures based on the research findings have been conducted by three Federal agencies—the Forest Service, the National Park Service, and the Bureau of Indian Affairs—and also by private timberland owners. The growth of these control activities is indicated by expenditures which have increased from $2,700 in 1906 to nearly $200,000 a year, by the Forest Service alone, in the last three years. Expenditures by the National Park Service during the last 3 years were from $40,000 to $50,000 a year, and those of the Bureau of Indian Affairs from $10,000 to $20,000. As will be shown in the section State Aid to Private Owners and Local Political Units, State aid to private owners in forest insect control amounts annually to about $1,206,000, consisting of State, county, and town funds mostly for gypsy moth control in New England, New York, and New Jersey.

In view of the great annual losses from forest insects—which, as stated elsewhere, have been variously estimated at from $100,000,000 to $150,000,000 a year—the service made available to the States through the national prosecution of forest insect investigations and control measures assumes large proportions. Few States escape loss from such insects as the mountain pine beetle, the Black Hills beetle, the western pine beetle, the pine butterfly, the spruce budworm, the hemlock looper, the gypsy moth, the southern pine beetle, and the numerous insects which damage felled logs, sawed lumber, and finished wood products in use. Federal legislation to provide direct financial aid to the States was proposed in 1931 (H.R. 5830 and S. 1862, 72d Cong., 1st sess.), whereby Federal funds not to exceed $250,000 for each cooperating State would have been available for the control of tree-killing forest insect epidemics on State and privately owned forest lands, if matched by equal funds furnished by the States. (This bill, while approved in principle by the Secretary of Agriculture, was adversely reported for immediate enactment.) This measure is similar to that for cooperative fire control authorized under section 2 of the Clarke-McNary Act (June 7, 1924, 43 Stat. 653) as amemded. Pending the enactment of such legislation, Federal aid to the States will remain incidental to the national program, but this does not mean that the actual benefit to the States will not be large.

An illustration of this Federal service to the States is afforded by the interception activities at ports of entry, to prevent the introduction of injurious foreign pests. This is unquestionably a Federal job and can best be handled by the organization now invested with this responsibility—the Bureau of Plant Quarantine.

The detection of insect outbreaks in the forest is primarily the function of the landowners—Federal, State, and private—yet past experience has indicated that more effective results are possible if such detection service utilizes the advice and cooperation of Federal officers of the Bureau of Entomology.

Forest insect research has developed during the past 30 years primarily as a Federal function, and it seems advisable to urge that the Federal activities in this line be continued and strengthened. Further development of the Federal work should be coordinated with the Federal forest experiment stations. This plan was inaugurated some few years ago and it has proven to be highly effective and advantageous to Federal and private interests.

A few States have undertaken independent research in the field of forest entomology, usually in connection with the academic work of forest schools, as the New York State College of Forestry, University of Minnestoa, University of Michigan, University of California, and the Oregon Agricultural College. The State of Maine has maintained a forest entomologist for several years. It is wise to urge further State activities either through universities or the State experiment stations, and the fullest possible Federal cooperation should be given. Such cooperation is already in existence at practically every point where forest entomological work is being conducted. Where States have important local problems and sufficient interest to provide some money for technical work, it should be possible for the Federal Government to assist by contributing funds or technical assistance that would aid in coordinating these activities with the Federal program. Several examples of this type of cooperation are now in effect.

The actual control of forest insects is a function of the land-managing agencies. Insect control on Federal, State, and private lands receives cooperation, as to technical methods, from insect control experts of the Bureau of Entomology whenever possible, but actual suppression costs are at present borne by the agency administering the lands. Federal aid has been advocated in control work on State and private lands where these are intermingled or where a menace exists that threatens other timber. In other words, the forest insect control program should be coordinated between Federal and State agencies, probably in some such manner as in fire prevention.

FOREST SERVICE RESEARCH

By E. H. **Frothingham**, Director, Appalachian Forest Experiment Station

Federal contributions to both agricultural and forest research take two forms, one of financial grants to the States for the State agricultural experiment stations, the other of direct Federal appropriations applied to building up a strong Federal research organization in the Department of Agriculture. The two types of organization are distinct in plan and scope of activity. The agricultural experiment stations are concerned primarily with State and local problems. The 11 regional forest experiment stations and the Forest Products Laboratory—which are the Forest Service field units of the Department of Agriculture research organization—deal, on the other hand, with national and regional problems, and with local problems only in connection with the management of the national forests. The regional forest experiment stations complement, and in no sense rival, the State agricultural stations. At the same time, while their fields are distinct, opportunities for effective cooperation are often afforded by national or regional forest problems with important State angles. Thus the Classified List of Projects of the Agricultural Experiment Stations, 1930 (U.S. Department of Agriculture Miscellaneous Publication No. 89) contains 21 projects involving cooperation with the regional forest experiment stations of the Forest Service.

The purpose of research by the Federal Forest Service is to supply the basic knowledge necessary for the best management of forest and range lands, and the best utilization of their products. Of the knowledge so obtained, a large part is of direct or indirect value to the States, to smaller political units, and to private timberland owners. This State-aid aspect of Forest Service research will be apparent from the following brief review of the major activities discussed in the section Research in the United States Forest Service, a Study in Objectives.

RESEARCH AT THE REGIONAL FOREST EXPERIMENT STATIONS

Each of the 11 regional stations is charged with the solution of problems pertaining to one of the major forest regions of the United States. These problems are classified under a very few subject heads: General forest management, active at all the stations; forest range investigations, at present in progress at 4 western stations; the forest survey, at 5 stations; forest economics other than the forest survey, at 3 stations; erosion-streamflow investigations at 6 stations; and forest products, at 3 western stations. The work is much more diverse than the small number of subjects might suggest. Within a single subject the problems take widely different forms corresponding to differences in the character of the forest and the uses made of forest lands and products. In the subject of forest management, for example, the eastern stations must give much more attention to problems of hardwood forestry than the stations in the West, where hardwoods are not important. The hardwood forest problems are themselves widely different as, for instance, those of the Northeastern States and the southern river bottoms. Naval stores investigations are limited to one station covering the longleaf and slash pine territory of the Southern States. The development of a forest-planting technique, on the other hand, though studied at every station, follows distinctly different lines in each region. These differences give each station its own distinctive field of regional activity, while all the stations combine to increase the national fund of knowledge in the major investigative subjects.

The concentration of forest research activities at regional stations places at the disposal of the States a local source of information much of which can be directly applied to the solution of State problems or those of private timberland owners. A good illustration is the naval stores research conducted by the Southern Forest Experiment Station and the Forest Products Laboratory in the southern pine region. From South Carolina to Texas the behavior of the turpentine-producing pines and the climatic and soil conditions affecting gum yields and extraction are sufficiently alike to warrant the expectation that research results obtained at representative points will be applicable with minor modifications at other points in the region. Thus the Federal work on such problems as prolonging the period of profitable turpentining, increasing the flow of gum, protecting the stand, or improving the management of the forest in other ways should be of quite general use, to individual States and to private operators in them. Similar illustrations could be given for every forest region served by a forest experiment station, and for every line of investigative activity. Thus, in forest-fire studies the results of the statistical analysis of past fires that is being made regionally by some of the forest experiment stations will incidentally assist State and private fire-protective organizations in improving their technique and efficiency. The regional studies of forest-fire damage similarly furnish local data applicable to State problems. In like manner, the Federal research in forest range management in the Western States, while regional in scope, has direct value to the States as a means for improving and perpetuating both the livestock industry and the production of timber within their boundaries.

In the field of forest economics, the research now being conducted by the Forest Service on a regional or national basis carries with it a high degree of usefulness to the States and to private timberland owners. In numerous instances this aid is direct, particularly in the State aspect of the investigations of forest taxation and insurance, financial aspects of forestry, and the forest survey. The research on economic problems of the forest industries and on statistics of production, consumption, and requirement is directly serviceable to the States, as a basis for public policy. This field of research is so broad and important to all work in forestry that no other investigative effort, State, regional, or national in scope, can be regarded as complete or fully satisfactory until its economic relationships have been defined.

For the mutual advantage of close contact between the regional stations, States, and private owners, the headquarters of the stations are placed in or near the larger cities and, where practicable, at university centers, so that the technical workers will be most readily available for consultation or cooperation on State problems. The size of the territories covered by the stations necessitates local concentrations of work at branch stations situated at points which are representative of the different important forest types of the region. This further enlarges the opportunities for contact and cooperation by the regional station personnel. At these branch stations, experimental forests are being established which constitute another fruitful source of aid to the States and private owners through the demonstration of experimental results. Five or ten such experimental forests will probably be required in each forest region. Similar forms of aid are presented in the experimental ranges, for the States in which range grazing of livestock is important; and in the natural areas which are being set aside on the national forests for research purposes.

Another effective means by which cooperative relations may be established and research at the regional stations brought more closely in contact with State and local agencies, is provided by the station advisory councils appointed by the Secretary of Agriculture. Through these councils the stations are brought into contact with representatives of State forestry departments, agricultural colleges, universities, industrial leaders, timberland owners, game and wild life organizations, and others.

In such ways as these the aggregate of assistance available from the regional stations to the State forestry agencies and private timberland owners is large, and not all of it is indirect. Most of the field projects, in fact, are constantly producing data of local value in the conduct of the regional studies, which have a direct bearing upon State forestry problems or those of private owners within the State boundaries.

RESEARCH AT THE FOREST PRODUCTS LABORATORY

Most of the forest-products research of the Forest Service is concentrated at the Forest Products Laboratory, at Madison, Wis. The laboratory investigations cover a wide variety of problems connected with forest-product utilization, from the cutting of the tree to the grading, selection, and conditioning of forest products, the fundamental study of their properties, their modification to resist decay, fire, or shrinkage, and the study of methods and kinds of wood for use in pulp and paper manufacture. The investigations cover also the design and adaptation of forest products with reference to strength and other properties, and manufacturing processes, such as gluing and painting. The laboratory tests of forest products are supplemented and coordinated with the work of the forest experiment stations in various ways, notably through studies of the relation between growth conditions and wood quality which are being conducted by the laboratory in cooperation with the regional stations and other agencies.

The work done at the Forest Products Laboratory is intimately related to many other forest activities. Since it is designed to extend the use of wood to new products, and to accomplish a better and closer utilization of timber, it contributes to forest conservation in general and to various phases of forest management in particular. Its results are of value to the States in numerous ways, as well as to local industries, and a considerable amount of the field work done by the laboratory is in close cooperation with both State and private agencies.

RESEARCH EXPENDITURES

The growth of the appropriations for Forest Service research from 1915 to the present is shown graphically in figure 1. From less than $300,000 in 1915, the total expenditures reached a maximum of nearly $1,800,000 in 1932, dropping to $1,667,000 in 1933. Since 1928, most of the research has been developed under the provisions of the McSweeney-McNary Forest Research Act, which embodies the scope and financial plan. Exceptions are the work on the relation of forests to erosion and stream flow, which is carried under the item for soil-erosion investigations in the appropriation act for the Department of Agriculture, and the studies of forest taxation and insurance, which are covered under the Clark-McNary Act. A proposed extension of the McSweeney-McNary Act to cover erosion stream flow investigations is discussed under the section Research in the United States Forest Service.

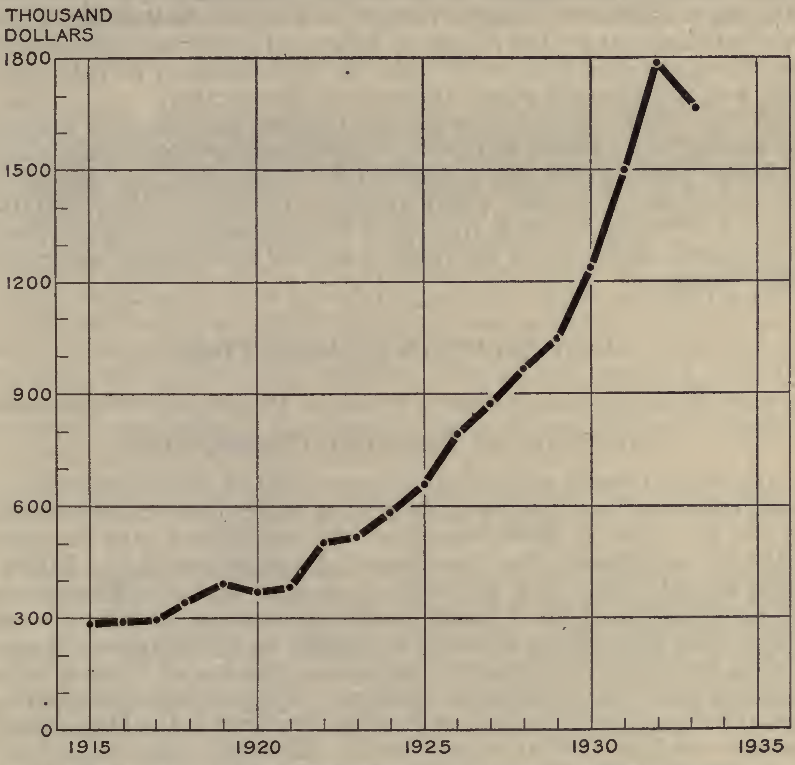

Figure 1.—Appropriations for forest research by the Federal Forest Service, 1915–33.

Between 1915 and 1932, the funds available for the Forest Products Laboratory increased from $130,744 to $534,430. The forest experiment stations received in 1921 a total allotment of less than $50,000 and in 1932, including appropriations for the forest taxation inquiry, they received $1,048,580, a twenty fold increase.

SUMMARY

While responsibility for research on State or local forest problems rests with the appropriate agencies in the States, the Federal research organization in its work on national or regional or local national forest problems is of both direct and indirect assistance to the States in many ways. Federal, State, and private forest-research agencies frequently aid each other through direct cooperation on local aspects of the regional problems studied by the Federal stations. Since all of the important forest types studied by the regional stations are common to more than one State, the research results obtained, though regional in scope, furnish much information that can be used by States and private owners in connection with their own problems. Intimately related to these investigations is the work of the Forest Products Laboratory the results of which aid forest management and forest conservation and are of value to the States, to private operators, and to industrial plants throughout the country.

In addition to research results, the regional stations offer facilities for assistance to States and private timberland owners through their technical staffs which are available for consultation or cooperation, the experimental forests where research results are demonstrated, and the advisory research councils which establish contact between the regional stations and the State and local forest-using agencies of many kinds.

INFORMATIONAL ACTIVITIES

By A. B. Hastings, Forest Inspector in Charge, Division of State Cooperation

DIFFUSION OF FORESTRY INFORMATION

Any effort toward permanent improvement in the management of forest resources depends for success upon widespread public recognition of the value of these resources. In compliance with the terms of the act establishing the Department of Agriculture (Act of May 15, 1862, sec. 511, title 5, U.S. Code), to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture, in the most general and comprehensive sense of that word, the Department maintains a number of types of informational activities relating to forestry. They include the distribution of bulletins and circulars on forestry prepared in the Department, forestry exhibits for State and county fairs and other expositions, motion-picture films, lantern slides for purchase or loan, special educational cooperation with the States and with clubs and institutions in the States, and extension work among timberland owners by agents of the Forest Service specially designated for this work. These activities in one way or another reach a very large number of people. It is estimated, for example, that motion-picture films on forestry subjects, of which 920 loans were made to State forestry agencies in 1931 by the Department, were seen by over 2¾ million people. In the same year the Forest Service loaned exhibit material of bromides, display panels, etc., to 13 States, and it is estimated that nearly 4¼ million people saw these. In 1932 approximately 90,000 persons viewed more than 11,000 Forest Service lantern slides loaned to a very wide variety of organizations in 26 States.

The special educational work consists of cooperation with teachers, club women, young peoples' forestry clubs, and other organizations. In 1931, 10 travelling school exhibits made up of picture panels, photographic prints, wood samples, and publications were loaned to 53 schools and a number of other organizations, and were shown to about 31,000 persons.

In connection with the cooperative fire protection work discussed in the section entitled "Federal Financial and Other Direct Aid to the States," the time of one man is devoted exclusively to giving addresses on forestry. The itineraries for these lectures are arranged by State forestry agencies. In 1931, 173 addresses were made to approximately 40,650 people. These lectures are believed to have aided materially in the spread of forestry information and enthusiasm and aided materially in bringing in valuable support to the State projects.

DEMONSTRATION AND ADVICE

Practically the entire time of two representatives of the Forest Service is spent among the owners of timberlands and farm woodlands in the East, with the object of improving forest practice by advice and demonstration. In the plains region of the West Central States an important contribution to forestry has been made by such field stations of the Bureau of Plant Industry as those at Mandan, N.Dak., Cheyenne, Wyo., and Woodbridge, Ohio. At the Mandan station, for example, trees have been produced and supplied to selected ranch owners for the establishment of demonstration windbreaks in eastern Montana and western North Dakota. This activity has been invaluable to the States of the Great Plains in connection with the successful development of tree distribution and farm forestry extension work, especially in the parts of these States where a deficiency in rainfall results in little or no natural tree growth.

NATIONAL COMMITTEE ON WOOD UTILIZATION, UNITED STATES DEPARTMENT OF COMMERCE

This committee, organized in 1925, is made up of about 200 members representing professional groups and trade associations interested in the production, distribution, and consumption of forest products. Its aim is to encourage reforestation through intelligent use of wood. The committee is particularly interested in furthering more efficient use of wood in building and construction. It works in close cooperation with both public and private agencies.

PUBLIC ACQUISITION OF PRIVATE LANDS AS AN AID TO PRIVATE FORESTRY

L. F. Kneipp, Assistant Forester, Forest Service

CONTENTS

Page
General reaction of private timberland owners to principle of public acquisition 1147
Economic justification and consequences of an enlarged public acquisition program 1150
  Acquisition of lands denuded, depleted, or in various stages of regrowth 1150
  Acquisition of lands supporting merchantable timber 1151
Public agencies engaged in the acquisition of forest lands 1158
Present purposes and objectives of Federal acquisition program 1160
Considerations governing Federal acquisition program 1161
  Effect on financial integrity of counties involved 1161
  Effect on existing or contemplated State or county forest-land acquisition programs 1162
  Effect on actual or probable private management of forests 1162
Methods by which Federal Government can acquire forest lands 1162
  Land exchanges 1162
  Cash purchases 1165
  Donations of lands suitable for national-forest purposes 1167
Development of national-forest system and present status 1168
  In western public-land States 1168
  Eastern States 1171

Within and contiguous to existing public forests is a great deal of privately owned forest land integrally related to and demanding management in common with the public holdings. Additionally, there are many forest areas not in public ownership where public action will be necessary to conserve the social and economic values of such lands. Some of such land may revert to the public through tax delinquency, but much of it can be publicly acquired only by equitable compensation to the owners thereof, either by payments in cash or bonds, or by grants of other publicly owned natural resources, or by agreement to special conditions of donation. The term "acquisition" as used in this discussiou therefore means the systematic establishment of public ownership in forest-productive lands by dedicating to that purpose public funds, resources, or administrative facilities.

GENERAL REACTION OF PRIVATE TIMBERLAND OWNERS TO THE PRINCIPLE OF PUBLIC ACQUISITION

The reactions of owners of private forest lands toward past, present, and proposed programs of public acquisition of forest lands may be divided into four broad classifications—one negative, the others favorable. In recent years a certain minority has envisioned the public-forest properties chiefly as potential future competitors in the function of timber supply, apprehensive of the effect upon future prices that would result from timber produced without taxation, with funds obtainable without interest charge or at rates of interest lower than those available to private enterprises, and with operating deficits justified by collateral public benefits.

On the other hand, numerous private owners of forest lands see in proposed programs of public acquisition of forest lands a new leadership by public agencies in the field of actual silviculture; a stimulation of research and experimentation through which more practical and profitable principles of forest-land management and utilization will be evolved and demonstrated for the common benefit of all timber-productive properties. To others, the proposed public forests are desired assurances of permanent sources of timber supply for established wood-using industries and communities which, by supplementing the supplies from inter-related private lands, will more certainly guarantee and stabilize sustained timber production and utilization and thus create better conditions for the private practice of forestry than would prevail in the absence of the public forests. Finally, other timberland owners regard the policy with favor because they see in it a public willingness to assume in greater degree obligations of forest-land ownership which cannot be borne by private owners; as a procedure by which they can, on terms equitable to all interests concerned, relieve themselves of an excessive burden of unliquidated stumpage by means other than destructive exploitation inimical both to private and public welfare.

The fear that the timber products of public forests will compete destructively for future markets can be considered only as an abstraction. Such competition has not thus far assumed alarming proportions nor does it appear to have serious future probabilities. It seems wholly inconceivable that any public agency would for any length of time be allowed to manage a public resource in ways destructive of sound private enterprise or otherwise inimical to the best economic interests of the region, State, or Nation. If any such tendency developed it would promptly be corrected. Then, too, as compared to private action, there is inevitably a certain inflexibility and routine in any form of public management which would tend to equalize advantages of tax exemption, cheaper credit, and smaller necessity for affirmative financial returns. All other factors being relatively equal, the greater flexibility, simplicity, and lower cost of private management should enable it successfully to compete with the products of public forests. Upon types of land where this is not true, where inherent disadvantages would militate against or preclude successful private-forest management, the unavoidable additional elements of cost of timber production should equalize whatever advantages of public administration there might be. The apprehension that the products of public forests generally could and would undersell the products of private forests lacks a valid and tenable foundation.

The future of forestry in the United States hinges largely upon the development of a technique in the management of forest lands which within practical limitations of costs will most adequately realize their potentialities for the production of timber commodities and related economic and social services. This not only requires the full exploration of the field of research and experimentation but also widespread and systematic demonstration of the principles and methods essential to highest use and their practical consequences, biologically, economically, and financially. Few if any private owners are prepared or disposed to pioneer this field; it is peculiarly a public function. Its generally beneficial consequences to private forestry already have been demonstrated beyond doubt. The function of research and demonstration is facilitated by the availability of adequate areas of public forest lands which can be managed for the purpose of deriving scientific facts rather than exclusively for monetary returns.

The creation of public forests within zones tributary to established wood-using industries and communities, especially those representing large fixed capital investments such as pulp and paper plants, is generally an additional assurance of permanence and stability. There are few large wood-using plants or dependent communities whose permanence does not vitally depend upon the systematic recreation of at least a part of the forest capital necessary to the future life of the enterprise. Ordinarily, existing and immediately prospective timber supply is adequate only for a part of a complete forest rotation or cycle of operation. Private provision of the timber products necessary to bridge over the hiatus or period of deficiency may not be economically practical. Barring public action, the early disintegration of the plant or community would be inevitable. With public cooperation through public acquisition and management of a part of the tributary forest land, the permanency of the plant or community may be definitely assured, thus promoting continued and constructive private management of that part of the forest area upon which such management is financially practicable.

Any program of public acquisition of forest land inevitably affords owners of such land opportunity to relieve themselves of its ownership. As now generally conducted, it does not afford them a means to unload at excessive prices. Principles and methods of land appraisal and purchase have now been so systematized and are so carefully conducted that the owners of the desired lands seldom are able to capitalize the public program for purposes of unearned profit in any save a minor degree. It is in some instances true that properties are not in demand by other buyers, that their owners tentatively or positively contemplate relinquishment through tax delinquency. But by the time the owners have complied with all of the requirements of public purchase, the nominal per acre value they may receive for such lands constitutes a negligible net consideration and by its payment properties which otherwise would pass through a long period of neglect and damage, with marked impairment of their productive values and progressively multiplying costs of regeneration, promptly are placed under efficient control and management and thus are more readily and economically restored to a condition of productivity. Even where it is reasonably certain that the lands eventually will revert to public ownership through tax deinquency, it nevertheless may be the highest public economy to allow a reasonable consideration for their early conveyance to public ownership, rather than to take over badly damaged lands 5 or 10 years later and expend much larger sums for their reclamation.

A program of public acquisition of forest lands, by permitting a private owner to divest himself of nonoperable properties whose carrying charges are forcing a destructive and uneconomic liquidation of stumpage values, may enable that owner to constructively and adequately manage a certain part of the ownership and thus aid very directly in the establishment of private forestry as a stable practice. Such a result promotes, with a minimum net cost, a maximum contribution to a national program of forest conservation.

ECONOMIC JUSTIFICATION AND CONSEQUENCES OF AN ENLARGED PUBLIC ACQUISITION PROGRAM

Even the tentative proposal of an enlarged program of public acquisition of forest lands will immediately give rise to a series of vitally important questions. One will be that of cost; of the ability of the public to finance such a program and the economic soundness of that type of public investment as compared to other pressing needs for constructive public action. Another will be that of political policy, of the logic and merit of a program which contemplates enlarged public participation in a field hitherto quite commonly regarded as one primarily of private initiative. Both of these questions hinge largely upon the answer to a third question, namely, the economic justification and consequences of such a program. The question of costs is not one of amount but of economic and social necessity and net beneficial consequences. The question of jurisdiction is not exclusively one of prerogative but of the most logical and effective method of collective public action. The facts which follow seem logically to imply that a substantially enlarged future program of public forest-land acquisition is fully justified and promises large beneficial economic consequences.

In any program of public forest-land acquisition the lands requiring consideration fall into two broad classes, viz: (1) those largely denuded of their forest cover or supporting only seedlings or saplings, or advanced second growth not yet of merchantable dimensions or quality, and (2) those supporting mature stands of timber of commercial size, quality, and volume. Units meeting the minimum requirements of efficient and economical public administration occasionally contain lands of only the first class but more commonly they embrace lands of both classes and in their adequate development as public properties it frequently is necessary to decide whether the heavily timbered lands shall be acquired as fast as funds are available and price agreements can be reached, or whether they shall be excluded from the purchase program until their mature values have been exploited by private enterprise and they can be acquired at low unit costs as cut-over lands. Past experience creates serious doubts as to whether the latter policy is in the long run the most economical, as the lower prices at which the cut-over and often seriously damaged lands can be acquired frequently are offset by losses of the revenues which could have been secured through sound operation of the mature stumpage, and/or by the added costs of restoring the lands to productive condition. Aside from this factor of the initial investment required to carry out a program of acquisition, other considerations of public policy deserve attention.

ACQUISITION OF LANDS DENUDED, DEPLETED, OR IN VARIOUS STAGES OF REGROWTH

Much of the land in this category has lost much or all of its power to provide men with creative employment, to support industries, to contribute to costs of local government or to otherwise promote desirable economic and social objectives. Any measure that will restore that power to a degree which in beneficial returns exceeds the costs of restoration has definite economic justification and beneficial consequences. There can be little question as to the essentiality of steps to conserve the social values of such lands. The only question is whether such action by public agencies would handicap private enterprise or benefit it. If the preponderant facts indicate that private enterprise would not be handicapped, but instead benefited, little argument remains against enlarged public ownership of lands in this classification.

With limited exceptions, individual or private action is wholly contingent upon the existence of a sufficient profit incentive. Where that is absent private enterprise quickly abandons the obligations of ownership. There is much forest land where the profit incentive is so obviously lacking, or is of such small degree, that the probability of successful private action in forest-land management may be dismissed from consideration. But while the monetary returns from such lands may not be sufficient to inspire continued private ownership the products of such lands if publicly administered will permanently contribute to the support of wood-using industries which by their successful and continuous operation will provide markets for the products of private forest lands and thus promote the practice of forestry to a degree not otherwise practicable. It may be the best economic doctrine for the public to assume the task of forest regeneration, leaving to private initiative the more practicable functions of harvesting, transporting, manufacturing, and merchandising the forest products. In general, the function of redeeming denuded forest lands and of carrying young stands of timber to economic maturity will be assumed by private enterprise under only the most favorable circumstances, and its assumption by the public under any other circumstances helps rather than handicaps private forestry. There is no significant competition between public and private enterprise in this field of forestry.

ACQUISITION OF LANDS SUPPORTING MERCHANTABLE TIMBER

If the 552 billion board feet of saw timber on the national forests, the 53 billion feet on other Federal lands, the 42 billion on State forests and the 32 billion feet on the Indian reservations administered by the United States on behalf of the Indians, or any substantial part thereof, were now in private ownership, the conditions of the lumber industry and of forestry generally would be much worse than they are. Current facts make it clearly evident that the initiation of a program of public retention and acquisition of forest-productive lands was highly beneficial not only to the public but also the timber industry and the individual owner of forest land. Instead of reacting adversely against the best economic interests of States and industries, the policy has, in large degree, safeguarded such interests. The present question is not of its possible curtailment but of the necessity for its considerable enlargement.

The forest situation in the United States presents a striking economic anomaly—a surplus of privately-owned timber in a country which faces a possible deficiency of future timber supply. If, during the past 40 years, the Federal Government had parted title with only that part of its timbered lands actually needed to supply current timber requirements, a major cause of the present wasteful depletion of forest lands and resources would not now exist.

But liberal public-land laws permitted private acquisition of areas of heavily timbered lands vastly in excess of current and immediately prospective timber requirements and thus vested in private ownership considerable areas of heavily timbered lands for whose products there is no economic necessity either at present nor within the next decade or more. The time will arrive when such timber will be indispensable to economic and social welfare and all considerations of public interest dictate that it shall be preserved from wasteful exploitation until that time, but at present the tendency of all but a small minority of the present owners of such timber is to follow a policy of quick liquidation notwithstanding the obvious fact that such a policy is uneconomic and against the highest public and private interest.

Just prior to the beginning of the century the belief prevailed that the timber requirements of the Nation would soon equal and shortly thereafter exceed the total available supply. In such circumstances large increases in stumpage values seemed inevitable. Nevertheless, stumpage then was relatively cheap and large areas of heavily timbered public land were easily obtainable at trifling expense. Costs of ownership were low. In consequence, a tremendous wave of private acquisition of timbered lands developed and continued for a decade or more. Single ownerships embraced scores and hundreds of thousands of acres of the finest timber on the continent. In general, the movement was motivated by speculative considerations.

The ensuing financial situation offered many opportunities to capitalize stumpage values which by force of other circumstances tended to increase with each passing year. Timber bonds were readily salable, loans readily obtainable. Invested capital demanded current returns. Meanwhile costs of State and county government not only increased but multiplied as need arose for more and better highways, schools, public buildings, and other forms of public service. Year by year the capital investment in the properties not only increased but more incessantly demanded at least partial liquidation. To accomplish that, mills, logging railroads, and other facilities for manufacture were imperative, these in turn adding largely to the capital investments pressing for current returns. As the invested value per unit of stumpage increased, its more effective protection against destruction by fire, disease, insects, etc., demanded heavier annual outlays. Through these several circumstances private forest ownership has tended in some sections to assume the proportions of an inverted pyramid, with no greater degree of stability and no greater assurance against eventual collapse. Getting the money out of the trees and into the bank seemed the one feasible method by which collapse could be averted. But to accomplish that a market for the timber was absolutely essential and demand was smaller than temporary supply.

The situation described, has in substantial measure now run its course. It was least acute in the New England States and the Appalachian region. In the southern pine region it has gone so far that the remaining timber stands are not greatly in excess of operating requirements, and to some degree a reaction has set in favorable to a new order of private forest-land management based on small capital investments in well stocked second-growth lands. In the Lake States the cycle is so nearly complete that the forest problem largely is one of regenerating cut-over lands, generally as a public function but with limited participation by private agencies such as the pulp and paper manufacturers whose large fixed investments will justify substantial outlays in forest-land management. In the southern Rocky Mountain region the smaller extent and wider distribution of ownerships and their relation to other industrial uses has tended to minimize the condition described. In Idaho, Montana, California, Oregon, and Washington, the States now containing the largest proportion of mature timber, the cycle is just now approaching its most acute stage, creating a situation which constitutes a real threat to the economic integrity of the lumber industry, to the States concerned, and to that part of the national interest dependent upon assured sources of timber supply and proper safeguarding of watersheds. While the timber is situated in the five States mentioned, the consequences of its enforced liquidation adversely affect all of the forest lands of the Nation. So long as Douglas fir can be delivered on the Atlantic seaboard at sacrifice prices, it will be difficult profitably to practice forestry on the white pine lands of New England or the short leaf pine lands of the Southern States. Under prevailing conditions timber products flow into any point of demand, and overproduction in any section of the country adds to a reservoir of manufactured timber which threatens to overflow economic safeguards.

Existing mills and operating properties are more than adequate to supply all current and immediately prospective timber needs. But the nonoperating properties represent large investments of capital, increased each year by current outlays for protection charges, taxes, and other costs of ownership. Furthermore, many of them are subject to outstanding bonded obligations representing large proportions of their appraised values, and interest charges must be met or foreclosure will result. In such circumstances the investment per unit of stumpage increases with rather alarming rapidity, and threatens within a relatively few years to exceed the probable realizable value of the stumpage. Owners assume or think that prompt liquidation is dictated. The historic and frequently only available method of liquidation is the operation of the timber. This means new sawmills added to already excessive mill capacity, new logging railroads in territories already containing too many, new lumber production added to a stream already overflowing all demand.

To secure a share of the business the owners of such properties must cut prices. In order to cut prices they also must cut costs. To cut costs the common although wholly mistaken practice is to forget all of the elements of good forest management and abandon all idea of maintaining the productive power of the land. Faced with the new competition other operators in the region similarly tend to cut prices and costs with the same consequences to the future values of the forest lands. Ultimately, the timber products of the new operation and its established local competitors, by reason of sacrifice prices, cheap water-freight rates and other factors, overflow the markets of remote sections, and immediately the timberland owners within or tributary to those sections correspondingly tend to cut prices and costs and to similarly abandon the idea of conserving the timber-productive values of their properties or conducting their operations on a sustained yield basis. The vicious cycle set in motion by the financial stress of new and economically unnecessary operations finally influences the future destiny of a major part of all the forest lands of the Nation.

It might be, and frequently is, reasoned that the owners of properties such as described should suffer the consequences of their own poor financial judgment; that it is no part of the function or obligation of the public to take over such properties and permit the owners to retrieve their unsound investments. If only the property owners were involved, this reasoning would be correct. However, the interests of the owners may become wholly insignificant as compared to the train of adverse circumstances set in motion by their attempts to salvage their investments. The ultimate economic consequences deserve serious consideration in such situations.

On the basis of sound social economy, timber for which there is no immediate need should be withheld from rather than forced into destructive competition. Its current operation seriously aggravates an already critical situation. In another quarter century the stumpage might conceivably do much to alleviate a different type of critical situation—one caused by a real deficiency of timber supply. However, the owners could not be compelled or expected to retain the timber uncut for that period of time except under a definite guarantee that through tax relief, fixed prices, bonuses of public money or otherwise, they would be compensated for all costs of ownership during the intervening period plus a proper return upon invested capital and managerial control.

In the circumstances described, it might be the highest public economy to take over the holdings subject to premature and uneconomic exploitation, establish them as public forests to be controlled and managed by appropriate public agencies, and hold the timber they support until its utilization is dictated by sound economic considerations. In this way the forest resources would be preserved from destruction, a large amount of capital would be kept available for other needs instead of being invested in unnecessary mills, railroads, and other manufacturing facilities, established lumber manufacturers would not be threatened with or actually thrown into insolvency, their forest lands would not be so destructively logged, and remote owners of forest lands sincerely endeavoring to practice forestry and maintain the productive power of their properties would not have their efforts nullified by forms of sacrifice competition they could not meet.

Such properties cannot be expropriated or taken over without equitable compensation to the owners. But such compensations should be based upon factual and actuarial determinations of sound investment values in the light of probable future trends in demand and value—not on the basis of unprofitable and possibly unwise investments which may have been made therein, nor on that of earlier standards of valuation which have markedly been modified by recent and prospective price trends. It should not be the purpose of a public forest-land acquisition policy to recoup the losses of timberland investors. If conducted under the principles herein proposed, the public acquisition of properties such as herein discussed would not comprehend a wastage of public funds. Consistently managed, with utilization deferred until need therefor acutally existed, and barring unforeseen calamities from fire or disease or insects or windthrow, the property should return to the public treasury the full costs of its acquisition and management. Meanwhile, in offset to taxes, it would be contributing to many social needs and rendering many forms of beneficial public service, not always susceptible of valuation in monetary terms or financial revenues but nevertheless distinct and of great public importance.

Aside from minor economies in production costs, financial returns from private forest properties of the kinds under consideration can be realized only by larger sales of products or by high returns per unit of product. Considering collectively the States of California, Oregon, Washington, Idaho, and Montana, larger sales would be possible only with demands for timber greater than those which can now foreseen. If Pacific coast stumpage is pressing inexorably for liquidation at the rate of 25 billion board feet per year and if total national lumber consumption does not exceed 30 to 35 billion board feet per year the impossiblity of increasing financial returns by a greater volume of sales becomes obvious.

Private owners of timbered lands are subject to all the inexorable laws of financial economy. To maintain financial solvency the periodically realizable values produced by a forest property must at least equal the values consumed by the processes of production during the same period. In the case of private ownership intangible and abstract social values not translatable into monetary returns cannot figure in the equation, no matter how essential and important they may be to general public welfare. Costs of ownership and production must be met by cash outlays and therefore must be offset by cash returns. In simple terms, the owners of large timbered holdings pressing for liquidation must reduce the costs of ownership or increase the financial returns of ownership if they are to avoid the wreckage of their properties, or bankruptcy.

New principles of forest utilization now in course of development and application promise substantial increases in net returns and markedly improved conditions for permanent forest practice. To the extent they prove to be practicable they will aid greatly to relieve the situation. In situations where such principles of utilization are inapplicable and where financial adjustments cannot be worked out under private ownership public participation is essential to the conservation of the economic and social values involved. Reduced to its elementary form, the solution of the problem presented by certain types of private forest ownership will lie in the willingness of the people of the United States to assume a larger part of the costs of such forest conservation either by relieving the private owner of a larger part of the costs of maintaining the property in a fully productive state, or by paying more for the commodities of the forests thus conserved, or by taking over the ownership and control of that portion of the unexploited forest area which, in the public interest, should be withheld from industrial exploitation until needed to meet actual public requirements, or by public regulation, which may have to be accomplished by provisions for expropriations.

Public contribution to decreased costs might take several forms. With the support of public credit properties might be refinanced at lower rates of interest with consequent reduction of financial pressure. The public might assume a larger share of protecting existing values against destruction by fire, disease, and insects. The public might underwrite a system of forest insurance under which the risk of forest-land ownership would be appreciably diminished. The public might grant partial exemption from annual taxes. None of these courses could be followed without substantial outlays of public funds or losses of public revenues.

The public also could increase the financial returns to the private owner of timberland. It could, for example, pay a bonus on lands managed in conformity with prescribed standards or principles. It could rebate taxes previously paid on such lands. Most practical of all, it could pay higher unit prices for the lumber and other timber products which it consumes and thus make it possible for the producers thereof more effectively to meet the true requirements of forest conservation.

The first question presented by this latter proposal is that of ways and means. So long as the products of the forest are subject to the free play of the laws of supply and demand, and so long as a surplus of forest products is competing for a limited market, and so long as the timberland owners believe themselves to be driven by financial necessity to liquidate regardless of the ultimate effect upon their forest properties or financial status, no way exists through which the public can be compelled to pay a greater share of the costs of adequate forest management, except by a modification of existing laws through which production could be controlled and correlated with demand, and the depressing effect of unrestrained competition upon unit prices could be averted.

Otherwise the better the market, the more existing mills are brought into maximum production, the more new mills are promoted. In such circumstances higher unit prices for timber commodities would not necessarily mean better forest management. Some definite and guaranteed correlation between production and consumption, stabilizing, and safeguarding the permanency and security of conservative forest management, would be an unavoidable essential.

Under American concepts of government and private enterprise it is quite natural to propose that the desired objective be attained by a compact or series of compacts between the timberland owners of the Nation, supported by State or possibly Federal regulatory powers and by State and Federal policies of public forest-land management and utilization. This would require drastic modification of existing public policies relating to combinations of industry or capital. Unless the compacts encompassed all large timber holdings, both operative and inoperative, each price advance would be merely an incentive to the installation of additional mill capacity and the operation of additional blocks of timber. No compact among timberland owners could be successfully maintained unless it embraced all actual and potential owners of such lands, and was susceptible of effective enforcement by legal processes. It would require new machinery for supervision and control. To be effective it would mean large increases in the costs of the lumber and other timber products consumed by the American people.

As an alternative to the adjustment of the present chaotic condition of the lumber industry by a program of controlled production leading to the establishment of higher prices per unit of timber product, thus endowing timberland owners with greater financial power to properly manage and utilize their properties, consideration properly may be given to the question of whether public acquisition of certain forest areas may not be the most equitable method by which the public may participate in the needful processes of forest conservation as related to such areas. By payment of higher prices the consuming public would create conditions more favorable to forest conservation, but it would not by that process be in a position to definitely dictate and enforce the minimum requirements of sound forest-land management, except by enactment of regulatory legislation, and the establishment of the necessary processes and machinery for its enforcement.

If the public must, in fact, contribute more fully toward the maintenance of acceptable conditions on forest lands now in private ownership, the preferable alternative might be for the public to take over, control, and manage the parts of the privately owned timberlands which by the menace of their actual or potential utilization cause the chaotic condition now prevailing in the lumber industry and the consequent antisocial waste and wreckage of natural values. By such a course the public would secure definite values in return for its cash outlays; would create by administrative action rather than new and only partially tested regulatory power the conditions essential to national security and progress, and would derive and enjoy the concrete social benefits and financial returns ultimately obtainable from the properties thus acquired.

The best data available show that of the total estimated stand of saw-timber in the United States, 79 percent is in the Pacific coast, northern Rocky Mountain and southern Rocky Mountain regions. The Pacific coast and northern Rocky Mountain regions alone contain 71 percent of the total stand. It is these regions primarily that are responsible for the overproduction of lumber which tends so strongly to disrupt normal processes of forest utilization and management, not only within their limits but nationally. The reason is not far to seek. Over 47 percent of the timber supply in these three western regions, 618 billion board feet exclusive of that in farm wood lots, is in private ownership. This is 20 times or more the normal annual consumption of the entire Nation.

In recent extensive studies made by the Forest Service, the stumpage in the western regions was classified into three zones, on the basis of 5-year average costs of conversion or manufacture and average selling prices for the products. The 5-year periods were from 1925 to 1929 in some instances; 1926 to 1930 in others. Zone 1 included the timber that on the bases indicated could be milled at a profit of 1 cent or more per thousand board feet; zone 2, the timber which could only be operated at a loss of from 1 cent to $5 per thousand feet; and zone 3, the timber where the operating loss would exceed $5 per thousand feet. On these bases, the privately owned timber in the Pacific coast, northern Rocky Mountain, and southern Rocky Mountain regions divides as follows: Zone 1, 373,568,000,000 feet; zone 2, 172,067,000,000 feet; zone 3, 99,514,000,000 feet. Considering California, Oregon, Washington, Idaho, and Montana, collectively, but excluding inferior species such as larch and fir for which there is but a limited demand, and excluding also, except in California, the private timber in farm wood lots, the timber in private ownership is classified as follows: Zone 1, 338,023,000,000 feet; zone 2, 155,953,000,000 feet, and zone 3, 85,749,000,000 feet; a total private holding of 579,725,000,000 board feet in the five States.

The greatest probabilities of early exploitation are of course, in zone 1, but under the stress of inescapable fixed charges operations also are conducted in zone 2, the stumpage absorbing the operating deficits. Zone 3 is largely safeguarded against early exploitation by the large margin of loss per thousand board feet. However, new developments such as new transportation facilities may modify the classification by throwing areas into zone 1 or zone 2. Moreover, since all of the land is subject to all costs of private ownership a given tract of timber even though it is not subject to profitable operation may by the burdens of its ownership compel the liquidation of more accessible stumpage to meet current costs.

In the circumstances described, public acquisition of heavily timbered lands, rather than being detrimental to private forestry, is one of the most practicable means by which private forestry can be placed upon a sound and stable foundation. Since the power of eminent domain is rarely exercised in forest acquisition programs and considerations allowed are held strictly to current market prices, the public would acquire only those lands which private agencies were indisposed or unable to carry until the utilization of their timber values was dictated by sound economic considerations. The policy therefore would be one of relief to private forestry rather than one of negation. Considering the nature and location of existing and proposed public forests, the public programs of acquisition largely would involve timbered lands in zone 3, the zone within which private operation is, and for some time will be, least practicable. Relieved of the burden of zone 3 properties, private operators would be in a far better position to manage their zone 1 and zone 2 holdings in conformity with good forest practices and sound economic principles.

PUBLIC AGENCIES ENGAGED IN THE ACQUISITION OF FOREST LANDS

Municipal acquisition of forest lands ordinarily is motivated by one or both of two purposes: The protection of the municipal watershed or the provision of areas within which the citizens can engage in various forms of outdoor recreation. In few cases is the municipally owned forest regarded primarily as a source of timber supply or of income from the sale of timber products; although frequently, as proved in European countries, it has large potentialities along those lines. In recent years, notably in New England, there has been a growing interest in "town forests" with increased emphasis upon revenue production. While the movement seems destined to grow in scope and importance as time goes on, it has not thus far attained large dimensions nor gained general recognition.

Similarly, in the instances where forest lands have been purchased by counties, or secured through exchanges of other county lands or resources, the element of public recreation has been prominent and though designated as forests the lands largely perform the functions of parks. Since tax-delinquent lands in many States revest in the county, only the heavily populated counties containing lands of high value and little subject to tax reversion hitherto have found it necessary to make appreciable purchases of forest lands to promote their programs. In few instances have the possibilities of well-managed forest lands as sources of permanent county income received constructive recognition; due probably to the fact that new standards of public improvement and service have drawn heavily on county finances, leaving little for types of investment that could be deferred. In counties largely comprising forest lands, the depletion of the timber values and consequent reduction of tax income to the county has tended to preclude any constructive action by the county. The number of counties systematically developing productive county forests will progressively increase, but neither in number nor in total acreage acquired will they be major factors in a program of public forestry in the near future.

The States are the smallest units of government, with rare exceptions, which have definitely formulated plans and programs of forest-land acquisition; and only a minority of the States offer present promise of carrying such programs into effective execution on any considerable scale. States which still retain large areas of public land granted by the Federal Government, and States containing large areas which have reverted to public ownership through tax delinquency, or which promise to so revert in course of time, do not need to devote part of their financial or other resources to the acquisition of additional lands upon which to initiate the processes of forest management; their chief problem is to make available the means with which to redeem the obligation imposed by present holdings or the involuntary accessions through tax reversion. In such States acquisition of additional lands by purchase, exchange, or donation will be important only as a means of creating better conditions of management and administration through the elimination of private holdings within units of management, or by the extension of unit boundaries to more logical limits of administration. In this category may properly be placed all States in the Lake, northern Rocky Mountain, south Rocky Mountain, and Pacific coast regions, and some of the States in the southeastern region.

So far as the next decade or so is concerned, the probability of extensive State programs of forest-land acquisition by cash purchase, exchange, or the solicitation of donations is strong only in the New England, Middle Atlantic, and Central regions, plus one or two States in the southeastern region. These groups of States now have little or no land granted by the Federal Government. Their populations are dense, their per capita wealth large, their lands possess sufficient economic values to warrant continued private ownership and tax payment, hence tax reversion is at a minimum. The social and economic importance of forests is widely recognized and State policies and programs of forest conservation are of longest standing and greatest permanency. Due to these circumstances these States offer greatest promise of progressively developing and expanding their State forest systems by systematic acquisition of the essential lands.

State principles and procedures of acquisition are not greatly dissimilar to those of the Federal Government. In each case sound and conservative principles of land valuation and appraisal are developed and adhered to. Purchases are confined to specifically defined areas established wholly on the bases of public value and necessity. Provision normally is made for executive or legislative supervision and control of purchases so as to avert any misuse of either public power or public funds. The net result has been to place in State ownership certain forest properties of major importance to public welfare, with clear and unencumbered titles and at costs safely within sound limits of actual monetary value. The section "State Accomplishments and Plans" so fully covers the subject of State holdings that their discussion here is unnecessary.

As is quite natural, the Federal program of acquisition through purchase, exchange, or donation thus far has developed with greatest rapidity and has attained the greatest present and prospective dimensions. It actually has been carried out in some degree in all of the 31 States containing national forests and should eventually extend to several more. Collectively it represents the largest area and investment of public funds to date and prospectively. Its continuous operation over a period of 21 years has served to stabilize the principles and policies by which it is directed and controlled. There has been a more systematic collection and recordation of factual data, making available detailed statistical information. Due to these several circumstances it is both feasible and desirable to discuss the Federal acquisition program in greater detail than is possible in relation to State, county, and municipal programs.

PRESENT PURPOSES AND OBJECTIVES OF FEDERAL ACQUISITION PROGRAM

Where national interests are concerned, and under prevailing public policies, the control and management of certain forested areas is properly a Federal function, and if the lands involved are not in public ownership and control, their acquisition is an essential prerequisite to effective Federal action. For example, the policy of Federal cooperation in protection of the watersheds of navigable streams and stimulation of timber production east of the Great Plains was almost wholly dependent upon Federal acquisition through cash purchase of the areas essential to the consummation of the project. In other words, in certain parts of the United States the Federal function of watershed and forest protection necessitates a broad program of land acquisition.

Unless it is complete and comprehensive, Federal ownership within any given area fails in some degree of its purpose, is less efficient, and more expensive. Privately owned lands interspersed among or contiguous to the Federal lands add greatly to costs of protection and seriously interfere with processes of utilization and management necessary to realize the full public values of the public properties. Lands owned by persons who will not cooperate in essential programs of forest protection against fire, insects, or disease markedly diminish the effectiveness and increase the costs of such protective measures. Lands which control access to and consequently the utilization of publicly owned natural resources frequently increase the costs and difficulties of such utilization or create undesirable monopolies. Where natural units of timber operation are characterized by diverse ownerships and conflicting plans or policies of use and management, it is impossible to manage the public properties as efficiently and economically as would be the case were the unit wholly in public ownership.

The present purposes and objectives of the Federal acquisition program, therefore, are (1) to create conditions most favorable for the redemption of Federal responsibilities within areas in other than Federal ownership and (2) to round out and consolidate existing Federal holdings in established national-forest units so as to promote their most efficient and economical protection and management and the highest degree of industrial and social use.

CONSIDERATIONS GOVERNING FEDERAL ACQUISITION PROGRAM

EFFECT OF FINANCIAL INTEGRITY OF COUNTIES INVOLVED

Lands in Federal ownership are not subject to taxation. The act of May 23, 1908 (35 Stat. 260), provides that one fourth of the gross revenues derived from sales of national-forest products or occupancy of areas shall be paid to the States for distribution to the counties containing national forests; but where all currently realizable commercial values have been removed from the land prior to its acquisition, as is frequently the case, there may be little or no current revenue until new crops of timber have been produced. In the interim the income received by the county may not adequately replace the taxes previously paid. In consequence the Federal Government, in all of its forest-land-acquisition program, must give careful consideration to the degree to which the acquisition of a given area will affect the financial and political integrity of the county or counties in which that area is situated.

In some instances it is so evident that the lands will revert to public ownership through tax delinquency and thereafter cease to contribute anything in the way of taxes that the county officials interpose no objection to their acquisition by the United States. In other instances the availability of the national-forest stumpage to be granted in exchange for the private lands may make possible the continued operation of a logging enterprise and furnish greater opportunity for employment and industry than otherwise would be the case; in which circumstance the county officials may endorse and support the transaction.

In other instances the increased net acreage in Federal control within a given county will permit it to share more generously in the receipts from the national forest or to qualify for an increased proportion of Federal aid in road and trail construction and thus offset, at least in part, the taxes which would be collected if the land continued in private ownership. Frequently enlarged participation by the United States in forest protection and development is regarded as offsetting possible losses of taxes. If, however, these considerations do not prevail, if it is evident that beyond a certain point acquisition by the United States would be inimical to the financial and political integrity of the local unit of government, limitations are established which will obviate such results. In some instances maximum limitations of area are agreed upon by the county, State, and Federal agencies and thereafter govern the Federal acquisition program within the particular region. Occasionally, as a means of safeguarding the integrity of agricultural communities, specifically defined areas within the exterior boundaries of the national forest or purchase unit are eliminated therefrom so as to obviate the possibility of their purchase. In other words, the acquisition program always is influenced by considerations of county interest. Where an exchange of any magnitude is pending consideration, the officials of the county concerned are afforded opportunity to informally indicate whether such exchange would be adverse to the welfare of the county, and if they make such a showing, the exchange is either modified or abandoned.

EFFECT ON EXISTING OR CONTEMPLATED STATE OR COUNTY FOREST PROGRAM

The Federal forest land acquisition program lacks any element of competition with similar programs of other political jurisdictions. Where State or county initiative reasonably is meeting the requirement of forest conservation or has definite future plans to do so, action by the Federal Government is, of course, unnecessary. In the formulation of the Federal program the effect on existing or contemplated State or county forest programs is therefore a major consideration; and where there is reason to believe that the inauguration of a Federal program of purchase would militate against an actual or contemplated State or county program, the Federal plan is appropriately modified. Usually there is no conflict except where the same lands are involved in both or several programs. Mere adjacency or or contiguity of State and Federal forest holdings is not an adverse but rather a favorable feature since it permits of better coordination and the various economies obtainable through cooperation. Many national forests adjoin and in some instances surround State forest units without appreciable detriment to the management of either property.

EFFECT ON ACTUAL OR PROBABLE PRIVATE MANAGEMENT OF FOREST PROPERTIES

Every public forest policy thus far evolved places the major dependence upon private initiative for future timber supplies and satisfactory management of forest lands. A program of forest-land acquisition which would minimize or defeat the fullest practical measure of private forest management therefore would be against the public interest, and any feature of the Federal acquisition program which would have that effect is either modified or abandoned.

METHODS BY WHICH FEDERAL GOVERNMENT CAN ACQUIRE FOREST LANDS

LAND EXCHANGES

The first legislative provision for the public acquisition of privately owned lands within national forests was the ill-famed forest-lieu selection provision of the act of June 4, 1897 (30 Stat. 11, 56), which had two major purposes: (1) to enable the private landowner to escape the assumed restrictions of a federally managed reservation, and (2) to promote the more efficient and economical administration of such reservations. The idea was good; the provisions for its enforcement wholly bad. The Secretary of the Interior was given no administrative discretion, no authority to withhold approval of selections involving disproportionate values. The law permitted owners of lands within national forests to do certain things and naturally the owners took advantage of it. The Secretary of the Interior could not deny landowners the right to do what the law allowed; even where he knew that the lands reconveyed to the United States were practically worthless and the lands selected in lieu thereof the finest and most valuable timberlands remaining in public ownership. The Federal departments could only protest against the law and urge its repeal, which finally was accomplished by the act of March 3, 1903 (33 Stat. 1246).

Because of the unsavory record of the Forest Lieu Selection Act, Congress naturally looked askance at any and all ensuing proposals to acquire privately owned lands by grants of other public resources or by cash payments. It was not until March 13, 1908, that the first national forest land exchange law was enacted; that relating only to the Crow Creek National Forest, Wyo. February 18, 1909, an act was approved permitting selections of unreserved public lands for private lands in the Calaveras Big Tree groves in California; and on February 28, 1911, another act authorized consolidations through exchanges in the Kansas National Forest in the State of that name. The act of March 4, 1911, authorizing exchanges within national forests in the State of Oregon was the first land-exchange measure of more or less general application. Other acts followed in quick succession until at present there are on the statute books a total of 56 acts of more or less general application and 13 which authorize exchanges with specifically named private owners or of specifically described lands. The date, statutory citation, field of operation, and major provisions of each of these acts are shown in table 1.

The fundamental difference between the objectionable Forest Lieu Selection Act and the various acts listed in table 1 is that the latter are all wholly in the discretion of the Secretary of the Interior and/or the Secretary of Agriculture and are operative only upon affirmative showing that a given exchange is definitely in the public interest and will vest in public ownership values at least as great as those granted in exchange. They do not endow the private landowner with any legal right or power to demand or compel an exchange nor do they sanction exchanges purely or primarily for the convenience of the private landowner. There must in each case be a demonstrable and dominant public purpose and benefit.

TABLE 1.—*Acts of Congress authorizing exchanges within the various national forests, Aug. 15, 1932*

Date of act	Forest	Authorizes—
Mar. 13, 1908 (35 Stat. 43)	Crow Creek National Forest.	Land in national forest for public domain military maneuvers, Wyoming.
Feb. 18, 1909 (35 Stat. 626)	Calaveras Big Trees.	Lands in forest for public domain.
Feb. 28, 1911 (36 Stat. 960)	Kansas	Lands within equal area and value. (All reconveyed.)
Mar. 4, 1911 (36 Stat. 1357)	National forests within Oregon.	Lands within.
May 7, 1912 (37 Stat. 108)	Calaveras Big Trees.	Do.
July 25, 1912 (37 Stat. 200)	Paulina	Lands within equal area and value.
Aug. 22, 1912 (37 Stat. 323)	Pecos, Zuni	Timber Pecos for timber and land Zuni. (Santa Barbara Pole & Tie Co.)
July 31, 1912 (37 Stat. 241)	State of Michigan	State lands equal area and value. (Either outside or within national forests.)
Apr. 16, 1914 (38 Stat. 345)	Sierra-Stanislaus	Timber and land for land within Yosemite National Park.
May 13, 1914 (38 Stat. 376)	Sierra	Lands within equal area and value.
June 24, 1914 (38 Stat. 387)	Ochoco	Do.
Sept. 8, 1916 (39 Stat 852)	Whitman	Land within for timber in or near national forest.
July 3, 1916 (39 Stat. 344)	Florida	Equal value.
Sept. 8, 1916 (39 Stat. 846)	Oregon	Do.
Mar. 3, 1917 (39 Stat. 1122)	National forests in Montana.	Timber selected in national forests.
Mar. 4, 1921 (41 Stat. 1364)	Carson	Land for equal value land or timber in forest.

TABLE 1.—*Acts of Congress authorizing exchanges within the various national forests, Aug. 15, 1932*—Continued

Date of act	Forest	Authorizes—
Feb. 27, 1921 (41 Stat. 1148)	Montezuma	Equal value land for land or timber in forest or on 320 acres adjoining.
June 5, 1920 (41 Stat. 980)	Sierra	Equal value land for land or timber in forest.
Mar. 4, 1921 (41 Stat. 1366)	Rainier	Do.
June 5, 1920 (41 Stat. 986)	Harney	Land equal value.
May 20, 1920 (41 Stat. 605)	Oregon	Land for land, equal value, or timber within forest
Feb. 2, 1922 (42 Stat. 362)	Deschutes	Lands within 6 miles or in forest for lands or timber in any Oregon forests.
Mar. 20, 1922 (42 Stat. 465)	All	General Exchange Act. Land for land or timber in national forest, equal value.
Mar. 8, 1922 (42 Stat. 416)	Malheur	Land for land or timber in forest, equal area.
Sept. 22, 1922 (42 Stat. 1036)	Wenatchee, Olympic, Snoqualmie.	Lands outside for lands or timber within, equal value.
Dec. 20, 1921 (42 Stat. 350)	Rainier	Lands for land or timber within forest, equal value.
Feb. 14, 1923 (42 Stat. 1245)	Lincoln	Lands in forest for lands outside, equal value.
Sept. 22, 1922 (42 Stat. 1017)	All	Land deeded to United States under act June 4, 1897, base of new selections outside forests.
Sept. 22, 1922 (42 Stat. 1018)	State of Idaho	School lands in forests for certain lands outside.
Mar. 3, 1925 (43 Stat. 1117)	Custer	Reservation coal offered lands.
Feb. 20, 1925 (43 Stat. 952)	Plumas, Eldorado, Stanislaus, Shasta, Tahoe.	Lands outside national forests for lands or timber within, equal value.
Feb. 28, 1925 (43 Stat. 1079)	Mount Hood	Do.
Mar. 4, 1925 (43 Stat. 1279)	Umatilla, Wallowa, Whitman.	Lands outside national forest for lands or timber under act Mar. 20, 1922.
Feb. 28, 1925 (43 Stat. 1090)	All	Reservation of mineral timber, etc., under act Mar. 20, 1922.
June 7, 1924 (43 Stat. 643)	Forests in New Mexico.	Private lands in Las Trampas grant for timber of equal value in any forest in New Mexico.
Jan. 12, 1925 (43 Stat. 739)	do	Private lands in Santa Barbara grant for timber of equal value in any forest in New Mexico.
Feb. 28, 1925 (43 Stat. 1074)	Snoqualmie	Lands outside for lands or timber within forest under act Mar. 20, 1922.
Mar. 3, 1925 (43 Stat. 1215)	All	Provisions of General Exchange Act extended to lands acquired under Weeks law.
Mar. 4, 1925 (43 Stat. 1282)	Whitman	Lands outside for land or timber within forest under act Mar. 20, 1922.
Apr. 21, 1926 (44 Stat. 303)	All forests in New Mexico and Arizona.	Lands within Mora grant for lands or timber within forests.
May 26, 1926 (44 Stat. 655)	Absaroka, Gallatin.	Private lands within for lands or timber within forests.
June 15, 1926 (44 Stat. 746)	National forests in New Mexico.	State-owned lands within forests for lands in forests or public domain.
Mar. 3, 1927 (44 Stat. 1378)	Arapaho	Lands outside for national forest land or timber.
Mar. 4, 1927 (44 Sta. 1412)	Colville	Do.
Feb. 15, 1927 (44 Stat. 1099)	Black Hills and Harney.	Lands within 5 miles for national forest land or timber, in forests named.
Mar. 2, 1927 (44 Stat. 1262)	State of Oregon	Select revested Oregon & California R.R. land in lieu school sections in national forests.
Apr. 16, 1928 (45 Stat. 431)	Carson, Manzano, Santa Fe.	Lands within private land grants.
Apr. 23, 1928 (45 Stat. 450)	Crater	Lands within 6 miles of national forest.
Apr. 10, 1928 (45 Stat. 415)	Challis, Sawtooth	Certain described lands outside national forests.
Mar. 26, 1928 (45 Stat. 370)	Manti	Lands outside national forests.
May 17, 1928 (45 Stat. 598)	Missoula	Certain described lands outside national forests.
Jan. 30, 1929 (45 Stat. 1145)	Montana	Lands within 6 miles of national forests.
Feb. 7, 1929 (45 Stat. 1154)	Lincoln	Lands within national forests for public domain.
May 14, 1930 (46 Stat. 278)	Fremont	Lands in certain described townships outside national forest.
Feb. 25, 1932 (47 Stat. 55)	Cache	Certain described lands outside national forest.
June 30, 1932 (47 Stat. 451)	Siuslaw	Extended to lands in T. 12 S., R. 6 and 7 W.
ACTS AUTHORIZING EXCHANGES WITH PRIVATE PARTIES		
July 15, 1912 (37 Stat. 192)	Black Hills, Harney.	John L. Baird.
May 14, 1914 (38 Stat. 377)	Cache	Joseph Hodges.
July 28, 1914 (38 Stat. 556)	Fishlake	Salina Land & Grazing Co.
Feb. 17, 1917 (39 Stat. 922)	Cache	Aquila Nebeker.
July 3, 1916 (39 Stat. 350)	Powell, Sevier	John L. Sevy.
Feb. 28, 1919 (40 Stat. 1204)	Cache	Jas. E. Hauser, Wm. H. Stewart, Isaac P. Stewart.
Feb. 28, 1919 (40 Stat. 1209)	do	C. Bolling, F. Zollinger, Jr., Conrad Alder, Robert Murdock.
June 4, 1920 (41 Stat. 757)	Colorado	John Zimmerman.
Jan. 7, 1921 (41 Stat. 1087)	Sevier	Henry Blackburn.
Feb. 7, 1921 (41 Stat. 1147)	San Isabel	A. A. Bruce.
Dec. 30, 1919 (41 Stat. 1455)	Powell, Sevier	Thomas Sevy.
Apr. 11, 1922 (42 Stat. 493)	Tahoe	William Kent.
Apr. 13, 1926 (44 Stat. 248)	Medicine Bow	Leo Sheep Co. Selected land outside.

A basic requirement of all the laws listed in table 1 is that the values revested in public ownership through exchange must be at least as great as the values relinquished by the public. To guarantee such result, careful and detailed examinations, cruises, and appraisals of both offered and selected properties or resources are made by qualified members of the Forest Service. The resulting reports, maps, and estimates of comparative values are then carefully reviewed and checked successively by the forest supervisor, the regional forester or his immediate assistants, and the forester or his immediate assistants, and no exchange is recommended to the Secretary of the Interior until all of these reviewing agencies are satisfied that in every respect and detail it fully meets the spirit and letter of the law under which it is being made. A further safeguard to public interest rests in the fact that practically all exchanges now consummated are made under laws which require that publicity be given to pending exchanges by advertisement in newspapers of general circulation within the counties in which the offered lands and the selected lands and/or stumpage are situated; so that each such exchange is a matter of common knowledge and subject to protest if any belief exists that it would be against public interest. Present legislative and administrative principles and procedures in national-forest land-exchange work thus completely eliminate any possibility that valuable public resources will pass into private ownership except under circumstances wholly in the public interest and at valuations equitable to the public.

CASH PURCHASES

By the time definite form was given to the policy of Federal acquisition of forest lands in the Eastern States for purposes of watershed protection, little remained in the way of Federally owned lands or timber resources within the territory involved. With negligible exceptions the lands essential to the program were privately owned, and could be acquired only by cash payments. The act of March 1, 1911, (36 Stat. 961), commonly known as the Weeks law, accordingly made and authorized appropriations to cover costs of purchase. Further appropriations later were authorized by the acts of April 30, 1928, and June 2, 1930. The record of total appropriations to date is as follows:

Fiscal year:	
1910 (all reverted to Treasury)	$1, 000, 000. 00
1911 (of which $1,982,679.24 reverted to Treasury)	2, 000, 000. 00
1912	2, 000, 000. 00
1913	2, 000, 000. 00
1914	2, 000, 000. 00
1915	2, 000, 000. 00
1916	None
1917	3, 000, 000. 00
1918	None
1919	None
1920	600, 000. 00
1921	None
1922	1, 000, 000. 00
1923	450, 000. 00
1924	450, 000. 00
1925	818, 540. 00
1926	1, 000, 000. 00
1927	1, 000, 000. 00
1928	1, 000, 000. 00

Fiscal year—Continued.	
1928 (supplemental)	$1, 000, 000. 00
1929	1, 000, 000. 00
1930	2, 000, 000. 00
1931	2, 000, 000. 00
1932 (of which $300,000 reverted to Treasury)	2, 000, 000. 00
Total appropriations	28, 318, 540. 00
Reverted to Treasury	3, 282, 679. 24
Net appropriations	25, 035, 860. 76

For so important a project, careful control and supervision obviously was necessary. To provide it the Weeks Law created the National Forest Reservation Commission, in which was vested the power of final approval of land purchases under the act. The project involved three of the executive departments of the Government; the War Department which had control over navigable streams, the Department of the Interior which handled the public lands, and the Department of Agriculture which functioned for the Federal Government in matters relating to forestry. The Secretaries of these three Departments therefore were made ex-officio members of the Commission, the Secretary of War to be the President thereof.

The project also was of direct interest to the legislative branch of the Government, so that the law provided that two Senators designated by the President of the Senate and two Representatives designated by the Speaker of the House should also be members of the Commission. Through the Commission both the legislative and executive branches of the Government participate directly in the execution of the provisions of the act. No purchases of lands can be made until they have been approved by the Commission, which usually meets in formal session about twice each year but functions additionally by recess action based upon detailed memoranda. While authority to determine the areas within which purchases should be made is vested in the Secretary of Agriculture by the act of March 1, 1911, the practice is to present to the National Forest Reservation Commission all facts relating to a proposed purchase unit and to secure its assent and concurrence before initiating any negotiations for purchase within such unit. Under the established procedure all expenditures of funds for land purchases are carefully supervised and controlled, and confined strictly to the purposes of the basic laws.

One of the basic provisions of the Weeks Law (section 7) is—

> That no deed or other instrument of conveyance shall be accepted or approved by the Secretary of Agriculture under this act until the legislature of the State in which the land lies shall have consented to the acquisition of such land by the United States * * *.

The States thus have full power to decide whether or to what extent the Federal Government shall be allowed to purchase lands for national-forest purposes. The majority of the State acts of consent under which purchases are made contain no limitations, but several apply to only certain specified parts of the State, one prescribes a maximum area for the State, one a maximum area allowable within any single county, two require the concurrence of the county commissioners, State conservation commission, and State land boards. No national-forest purchase unit can be established nor purchases made therein except in conformity with the provisions of the State act of consent.

Following the establishment of a national-forest purchase unit, ownership of the lands embraced therein are determined and recorded. The willingness of the United States to receive and pass upon offers of sale is publicly announced, and persons desiring to offer their lands are furnished with printed forms upon which their proposals can be presented in detail. As they are received the proposals are carefully reviewed and if the proposed conditions of sale, including the price asked for the property, are deemed reasonable, a careful examination, cruise, and appraisal of the property is then made by a trained and experienced examiner. Values for soils and young growth are based upon values prevailing in local commercial practice as checked by comparisons with values established by earlier purchases in other older units. Stumpage values are worked out by determinations of utilization or conversion costs as against average sales prices of lumber or other products in the appropriate markets; and are checked against stumpage values established by earlier purchases in other comparable units. Standards or bases of valuation are checked periodically and revised as necessary. All details related to a given tract of land are combined in a single report, which is then reviewed and checked in turn by the forest supervisor, the regional forester or his immediate assistants, and the Forester or his immediate assistants. The acceptance of an option on an offered tract is not authorized until the reviewing officers are completely satisfied that the price demanded is conservative and equitable and the conditions of sale are wholly acceptable.

Upon receipt of an acceptable option the case is then ready for presentation to the Commission, each member thereof being furnished with a detailed digest of all facts as to the character of the offered land, timber volume, value, etc. All conditions of purchase, even minor reservations of negligible importance are brought to the attention of the Commission. If later title investigations disclose new conditions not previously approved by the Commission the case must be resubmitted and again approved before payment for the land can be made. All titles must be approved by the Attorney General prior to their acceptance. A member of the office of the Solicitor of the Department of Agriculture, and corps of title attorneys and abstractors working under his supervision, has charge of and full control over all features of the title work, independently of the Forest Service. The funds appropriated for the purchase of lands are disbursed under the supervision of the chief disbursing officer of the Department of Agriculture and, of course, the Comptroller General.

DONATIONS OF LANDS SUITABLE FOR NATIONAL FOREST PURPOSES

There are certain owners of forested or forest-productive lands who for sentimental reasons desire that such lands shall be fully conserved and safeguarded but who are unprepared to permanently bear the costs of properly protecting and managing such lands. There are others who are sincerely interested in promoting forest conservation and, as a step in that direction, are disposed to dedicate to public forest purposes lands from which they otherwise could derive some financial returns. There is another and rapidly growing class possessed of large areas of forest land, generally cut-over, but occasionally bearing timber of commercial size and quality, but inaccessible, who cannot foresee any future private or public market for such land and are willing to donate it outright rather than allow it to go through the proplonged processes of tax reversion.

In such cases, if the lands are of such character and so situated as to make them valuable for national-forest purposes, donation to the United States can be accomplished under either of two acts now on the statute books. One is the act approved March 3, 1925 (43 Stat. 1133), which authorizes the Secretary of Agriculture to accept donations of land for any national-forest purpose. The other is the act of June 7, 1924 (43 Stat. 653), of which section 7 is as follows:

> That to enable owners of lands chiefly valuable for the growing of timber crops to donate or devise such lands to the United States in order to assure future timber supplies for the agricultural and other industries of the State or for other national forest purposes, the Secretary of Agriculture is hereby authorized, in his discretion, to accept on behalf of the United States title to any such land so donated or devised, subject to such reservations by the donor of the present stand of merchantable timber or of mineral or other rights for a period not exceeding twenty years as the Secretary of Agriculture may find to be reasonable and not detrimental to the purposes of this section, and to pay out of any moneys appropriated for the general expenses of the Forest Service the cost of recording deeds or other expenses incident to the examination and acceptance of title. Any lands to which title is so accepted shall be in units of such size or so located as to be capable of economical administration as national forests either separately or jointly with other lands acquired under this section, or jointly with an existing national forest. All lands to which title is accepted under this section shall, upon acceptance of title, become national forest lands, subject to all laws applicable to lands acquired under the act of March 1, 1911 (36 Stat. 961) and amendments thereto. In the sale of timber from national forest lands acquired under this section preference shall be given to applicants who will furnish the products desired therefrom to meet the necessities of citizens of the United States engaged in agriculture in the States in which such national forest is situated: *Provided,* That all property, rights, easements, and benefits authorized by this section to be retained by or reserved to owners of lands donated or devised to the United States shall be subject to the tax laws of the States where such lands are located. (See also section 555, title 16, U.S. Code above.)

During the first several years these acts were in effect, donations were few in number and small in area; inspired mainly by sentimental considerations. But interest in this method of passing forest land to Federal ownership now is rapidly increasing and over 100,000 acres of timber productive land of good site quality recently have been conveyed to the United States. Present and prospective circumstances indicate that a large acreage of cut-over timberland will in time be donated for national-forest purposes without cost to the public other than the small charges for title adjustments and recordation.

DEVELOPMENT OF NATIONAL FOREST SYSTEM AND PRESENT STATUS

IN THE WESTERN PUBLIC LAND STATES

The policy of withdrawing for national-forest purposes unreserved and unappropriated public lands chiefly valuable for timber production and watershed protection was initiated by the act of March 3, 1891 (26 Stat. 1095), and accelerated by the act of June 4, 1897 (30 Stat. 11). As a result of the withdrawals made during the past four decades there are now in the western half of the United States 121 national-forest units embracing a gross area of 151,012,085 acres, of which 133,161,417 acres are in Federal ownership; the difference of

17,850,668 acres comprising lands in State, county, or private ownership.

Not all of the federally owned timber-bearing lands are in national forests. Considerable areas are in national parks. Lesser areas are embraced in national monuments and reclamation withdrawals. Lands formerly comprising parts of the grants to the Oregon & California Railroad Co. and the Coos Bay Wagon Road Co., which were revested in the United States under the act of June 9, 1916, aggregate nearly 2½ million acres chiefly valuable for timber production and streamflow protection. In addition to the areas thus reserved for various purposes other than forestry there remains an appreciable area of unreserved and unappropriated public domain which supports or has supported timber of commercial value or of great importance for watershed protection. It would be wholly consistent with prevailing Federal policies of land management to permanently add such unreserved and unappropriated public lands to the national forests so as to safeguard their future values for timber production and streamflow stabilization. That, however, is a matter of congressional or Executive action outside of the scope of the acquisition program.

As above indicated the 121 national forests in the western United States contain 17,850,668 acres in ownerships other than Federal. Prior to the creation of the national forests title to much of the choicest and most productive timberlands had been established by the operation of State or other land grants and by private appropriation. These lands seldom occur in solid bodies of large extent but as a general rule are widely interspersed among the national-forest lands to which they normally bear an integral relationship. A certain part of the privately owned land clearly is best adapted to private management for grazing, agricultural, recreational, or other uses or services within the field of private initiative. Approximately 10 to 12 million acres of it is most valuable for timber production and should be under the same protection and management as the intermingled national-forest lands. Some of this land has been depleted of its timber value by logging, fires, insects, disease, or windthrow, or a combination of two or more such causes; much of it still supports heavy stands of timber of commercial size and quality which could most economically be utilized in conjunction with the public timber in the same unit.

The boundaries of the national forests in the western public-land States frequently were dictated by the lines of private ownership and thus fall far short of encompassing the natural limits of the timbered areas of which they are parts. In consequence there are outside of but contiguous to the national forests millions of acres of other timber-productive lands, in part cut over, in part still bearing virgin stands of timber, which likewise are integral parts of the national-forest units. They should be governed by the same plans and principles of management and utilization, subject to the same systems of protection and physical development. Their jointure with the publicly owned properties would mean the highest and best use and development of both properties; the mitigation of the condition of unrestrained and destructive exploitation, so detrimental to related national-forest lands, which otherwise seems inevitable under prevailing circumstances.

The fullest realization of the public purposes and values of the national forests depends upon the degree to which these intermingled or related lands come under the same administration and management.

Some of them doubtless will be donated to the United States; others can be acquired by giving in exchange other national-forest lands of lesser public importance and value or equal values of national-forest stumpage. The net value at which they would be obtainable is therefore largely conjectural.

So far as the western public domain States are concerned, the only hitherto prevailing policy and program of forest-land acquisition has been that of exchanges of national-forest land and/or stumpage for privately owned lands within the national forests, or in some instances within adjacent areas defined by special acts of Congress. Since 1908, Congress has enacted 56 laws of more or less general application and 13 laws specifically describing the lands subject to exchange, under which exchanges can be made. Under these various laws a total of 830 separate exchanges have been made, involving Federal acquisition of 1,205,100 acres of land valued at $4,773,519, and the grant in exchange therefore of 390,415 acres of national-forest land valued at $1,795,099 and 858,268 M board feet of national-forest stumpage valued at $2,377,820. The net gain in national-forest area thus has been 814,685 acres, but the gain in timber-productive area has been greater than that since nearly all of the offered land was timber-productive soil while much of the selected land was of low forest value and desired primarily for grazing use.

The cumulative record of land exchanges by States is contained in table 2. Included in the table are exchanges made with the States of California, Michigan, and Nebraska, whereby the respective State and Federal holdings were consolidated in units susceptible of most effective and economical management. The table does not include earlier agreements with the States of Idaho, Montana, Oregon, South Dakota, and Washington, under which these States relinquished 1,200,980 acres within the national forests, and selected 275,000 acres of other public domain lands, plus 924,362 acres eliminated from the national forests to permit such selection.

However, the exchange authority does not fully meet the present need. To begin with, the commodity most desired in exchange for privately owned lands is salable national-forest stumpage, and the employment of large volumes of such stumpage necessarily curtails receipts to the Treasury and the shares thereof paid to the counties embracing national forests. To avoid injustice to those counties, the rule has been adopted that the value of the national-forest stumpage granted in exchange for private lands during any given year shall not markedly exceed 10 percent of the value of the stumpage sold for cash. Under this policy curtailed national-forest timber-sale activity means also the curtailment of private-land acquisition through exchange. The other adverse feature of the land-exchange policy is that it does not meet the needs of the owners of large bodies of heavily timbered operable lands, who would be willing enough to dispose of their properties for cash but have no desire to exchange them for national-forest lands of similar character and value. Due to this fact only a minor part of the lands hitherto acquired through exchanges support large volumes of currently merchantable timber.

TABLE 2.—*Number of land-exchange cases consummated up to Dec. 31, 1931*

State	Number	Land conveyed to the United States		Selected land granted in exchange		Timber granted in exchange	
		Area	Appraised value	Area	Appraised value	Volume	Appraised value
		Acres		*Acres*		*M board ft.*	
Arizona	24	173, 894	$308, 581	8, 864	$21, 321	109, 733	$267, 004
Arkansas	4	32, 945	61, 679	146	1, 030	7, 746	59, 580
California	85	175, 729	1, 414, 430	25, 671	481, 667	216, 811	675, 308
Colorado	168	75, 074	321, 602	25, 592	64, 456	59, 099	167, 270
Florida	11	55, 917	116, 562	21, 015	42, 181	12, 514	72, 785
Idaho	68	59, 897	155, 443	538	2, 546	19, 745	127, 368
Michigan	20	136, 004	227, 733	135, 113	198, 248	----------	----------
Minnesota	16	2, 854	16, 985	26	16	2, 796	12, 825
Montana	87	129, 462	263, 185	76, 929	191, 707	24, 747	72, 942
Nebraska	1	8, 960	44, 800	8, 959	44, 793	----------	----------
Nevada	1	3, 504	6, 728	3, 520	6, 013	----------	----------
New Mexico	34	68, 006	295, 161	8, 076	14, 415	109, 427	266, 122
North Carolina	1	71	144	1	4	----------	----------
Oregon	178	181, 592	1, 091, 886	44, 914	571, 274	199, 592	434, 134
South Dakota	28	8, 666	28, 276	418	1, 916	5, 002	19, 221
Tennessee	1	14	70	----------	1	----------	----------
Utah	39	29, 070	155, 175	27, 903	145, 017	----------	----------
Washington	48	57, 269	232, 510	967	5, 195	85, 625	185, 627
Wyoming	16	6, 172	32, 569	1, 763	3, 299	5, 431	17, 634
Total	830	1, 205, 100	4, 773, 519	390, 415	1, 795, 099	858, 268	2, 377, 820

EASTERN STATES

The proposal that the Federal Government acquire and permanently manage certain forest areas in the Eastern States apparently originated, or at least was first formally expressed, at Asheville, N.C., in 1899. Different agencies interested in the development of the Southern States had noted with concern the rapidity with which the original stands of timber were being exploited and the ensuing impoverishment of the lands through fire and erosion. Their interest was esthetic as well as economic, and the first tentative proposals were for the establishment of national parks, but in time sentiment crystallized in favor of national forests as a more practical form of Federal administration. The idea quickly found favor in New England where the rapid progress of timber utilization was likewise creating alarm; so that the two widely separated regions joined in support of the new proposal of Federal participation in the solution of the rapidly enlarging problem.

So radical a departure from previously existing concepts of Federal functions inspired widespread differences of opinion, not only among Members of the Congress but among laymen as well. The constitutionality of the proposal was both attacked and supported by eminent authorities on the subject. Conferences and hearings were held, not only by congressional committees but also by organized unofficial groups and agencies. In all, the subject was under detailed consideration for a total period of 12 years. At the end of that period Congress enacted the law of March 1, 1911 (36 Stat. 961), popularly known as the "Weeks Law" because of its sponsorship by John W. Weeks, then a Representative from Massachusetts but later to be a Senator from that State and eventually Secretary of War. The primary purpose of the act was to safeguard the navigability of streams by maintaining on their upper headwaters the forest cover necessary to prevent excessive run-off and erosion.

The Weeks Law is generally applicable to all parts of the United States, but it was enacted to meet conditions which were particularly acute in the Eastern States. Its practical application, as a matter of administrative policy, therefore has been limited to those States situated east of the Great Plains, since the extensive areas of public lands in the Western States afforded a large field of Federal action without additional acquisition through cash purchase.

As originally formulated, the purchase program contemplated the eventual purchase of approximately 1 million acres in the New England States and 5 million acres in the Southern Appalachian region. In time the program was enlarged to include the national-forest units in Arkansas, and later to permit the establishment of a unit in northwestern Pennsylvania. Meanwhile, changes were made in the boundaries of previously established areas so that they would more effectively serve the purpose of their creation. At the close of the fiscal year 1924 there were 23 approved purchase units (later consolidated into 18) with a combined gross area of 9,568,515 acres.

Under the Weeks Law, purchases were confined to areas on the upper headwaters of navigable streams where the maintenance of a forest cover was found by the United States Geological Survey to favorably influence the navigability of the stream. This limitation debarred from consideration the vast forest areas in the Lake States and the southern pine belt of the South Atlantic and Gulf States, where the need for constructive public action in forest conservation became more acute with each passing year. In consequence a demand arose for the extension of the Federal purchase program to such regions as a means of determining, demonstrating, and stimulating better forest practice. In response to that demand the Sixty-seventh Congress, by Senate Resolution 398, created a Senate select committee of five members, which made an exhaustive study of the entire situation, holding hearings throughout the country at many important centers of timber production and use. Its findings, Senate Report No. 28, Sixty-eighth Congress, recommended amendment of the Weeks Law to include timber production as an objective of Federal management; which was done by the act of June 7, 1924 (43 Stat. 653), popularly known as the "Clarke-McNary law."

Pursuant to the purpose of that law an enlarged program was submitted to and approved by the National Forest Reservation Commission, under which 20 new purchase units designed primarily to stimulate timber production were proposed and eventually established. Meanwhile need was established for three additional units primarily to protect watersheds and these also were approved.

The full extent, present attainment, and requirements for completion of the hitherto established acquisition program in the Eastern States, under the Weeks Law as modified by the Clarke-McNary Law, is set forth in table 3. It shows that primarily for watershed protection 21 national-forest purchase units have been created in 16 of the Eastern States. They contain a gross area of 10,696,453 acres, of which 4,717,307 acres is now under Federal control. Of this, 3,728,083 acres have been acquired by purchase at a total cost of $18,832,667.64, an average of $5.05 per acre.

TABLE 3.—*Federal acquisition program, accomplished and proposed*

(A) PRIMARILY FOR WATERSHED PROTECTION

Region and State	Accomplished up to June 30, 1932									Required to complete existing units					
	Units established [1]	Gross area	Area federally managed	Ratio, federally controlled to total forest area of State	Area purchased or in process of purchase	Ratio, purchased to total acquired	Average cost per acre	Total cost of purchase and relation to total expenditure		Additional area to be acquired [2]	Total then under Federal management	Ratio, federally managed to total forest in State	Average cost per acre	Total cost of purchase and relation to total expenditure	
	Number	*Acres*	*Acres*	*Percent*	*Acres*	*Percent*			*Percent*	*Acres*	*Acres*	*Percent*			*Percent*
New England:															
Maine	[1] Part.	53, 300	33, 781	0. 23	33, 781	0. 71	$5. 74	$193, 792. 06	0. 91	[2] 19, 019	52, 800	0. 36	$5. 75	$109, 359. 25	0. 35
New Hampshire	Part.	801, 900	500, 955	11. 13	500, 955	10. 60	8. 68	4, 348, 270. 27	20. 51	276, 245	777, 200	17. 26	6. 00	1, 657, 470. 00	11. 60
Vermont	1	102, 100	31, 491	. 96	31, 491	. 67	11. 01	346, 672. 00	1. 64	268, 509	300, 000	9. 14	8. 50	2, 282, 326. 50	5. 08
Regional total	2	957, 300	566, 227	2. 54	566, 227	11. 98	8. 63	4, 888, 734. 33	23. 06	563, 773	1, 130, 000	5. 07	7. 18	4, 049, 155. 75	17. 27
Appalachian:															
Alabama	1	198, 425	134, 535	. 62	116, 826	2. 47	4. 86	567, 597. 79	2. 68	20, 550	155, 085	. 72	5. 00	102, 750. 00	1. 30
Georgia	Part 3.	660, 600	341, 797	1. 48	341, 783	7. 23	5. 37	1, 836, 683. 20	8. 66	266, 013	607, 810	2. 64	4. 65	1, 237, 692. 75	5. 94
Kentucky	1	580, 000	--------	--------	--------	--------	--------	--------	--------	509, 000	509, 000	4. 83	5. 00	2, 545, 000. 00	4. 92
North Carolina	Part 8.	1, 338, 500	451, 160	2. 14	439, 721	9. 30	5. 79	2, 545, 007. 49	12. 00	800, 854	1, 252, 014	5. 94	4. 30	3, 440, 853. 50	11. 56
Pennsylvania	1	726, 340	371, 201	2. 81	371, 181	7. 85	4. 79	1, 778, 725. 28	8. 39	234, 999	606, 200	4. 59	6. 00	1, 409, 994. 00	6. 16
South Carolina	Part.	244, 300	48, 950	. 39	48, 950	1. 03	5. 88	287, 755. 66	1. 36	188, 170	237, 120	1. 88	4. 00	752, 680. 00	2. 01
Tennessee	Part 3.	865, 100	393, 672	2. 76	393, 668	8. 33	4. 82	1, 897, 925. 57	8. 95	394, 896	788, 568	5. 54	4. 49	1, 773, 082. 25	7. 09
Virginia	Part 4.	1, 244, 500	619, 825	4. 10	619, 690	13. 11	3. 67	2, 272, 324. 88	10. 72	490, 244	1, 110, 069	7. 34	4. 22	2, 067, 160. 00	7. 61
West Virginia	Part 2.	819, 100	336, 102	3. 38	336, 102	7. 11	3. 43	1, 152, 103. 36	5. 43	376, 155	712, 257	7. 15	3. 91	1, 469, 129. 50	5. 06
Regional total	14	6, 676, 865	2, 697, 242	1. 91	2, 667, 921	56. 43	4. 62	12, 338, 123. 23	58. 19	3, 280, 881	5, 978, 123	4. 23	4. 51	14, 798, 342. 00	51. 65
Ozarks:															
Arkansas	Part 2.	2, 221, 522	1, 288, 920	5. 82	342, 841	7. 25	3. 44	1, 177, 665. 07	5. 55	765, 652	2, 054, 572	9. 28	4. 06	3, 105, 663. 50	8. 27
Oklahoma	Part 2.	344, 249	61, 489	. 52	61, 489	1. 30	1. 46	89, 663. 07	. 42	297, 000	358, 489	3. 03	2. 50	742, 500. 00	1. 61
Regional total	3	2, 565, 771	1, 350, 409	2. 62	404, 330	8. 55	3. 13	1, 267, 328. 14	5. 97	1, 062, 652	2, 413, 061	4. 68	3. 62	3, 848, 163. 50	9. 88
Gulf and Southeast:															
Louisiana	1	105, 567	24, 575	. 13	24, 575	. 52	3. 18	78, 217. 78	. 37	68, 992	93, 567	. 49	3. 65	251, 820. 80	. 64
Mississippi	1	325, 000	65, 030	. 35	65, 030	1. 38	4. 00	250, 264. 16	1. 23	194, 970	260, 000	1. 40	5. 00	974, 850. 00	2. 38
Regional total	2	430, 567	89, 605	. 15	89, 605	1. 90	3. 78	338, 481. 94	1. 60	263, 962	353, 567	. 60	4. 65	1, 226, 670. 80	3. 02
Puerto Rico	--------	65, 950	13, 824	3. 07	--------	--------	--------	--------	--------	--------	13, 824	3. 07	--------	--------	--------
Total watershed units	21	10, 696, 453	4, 717, 307	1. 86	3, 728, 083	78. 86	5. 05	18, 832, 667. 64	88. 82	5, 171, 268	9, 888, 575	3. 90	4. 63	23, 922, 332. 05	81. 82

[1] Where single units are in 2 or more States they are counted in each State, but regional totals show the correct number in each region.

[2] This column includes proposed extensions of existing units as follows: Green Mountains, 198,000 acres; Mount Mitchell, 2,000 acres; Unaka, 52,000 acres; French Broad, 111,300 acres; Monongahela, 153,800 acres; Kiamichi, 26,000 acres; Hiawatha, 118,000 acres; Huron, 1,000 acres; and Ottawa, 90,000 acres.

TABLE 3.—*Federal acquisition progam, accomplished and proposed*—Continued

(B) PRIMARILY TO STIMULATE PRODUCTION OF TIMBER

Region and State	Accomplished up to June 30, 1932									Required to complete existing units					
	Units established	Gross area	Area federally managed	Ratio, federally controlled to total forest area of State	Area purchased or in process of purchase	Ratio, purchased to total acquired	Average cost per acre	Total cost of purchase and relation to total expenditure		Additional area to be acquired	Total then under Federal management	Ratio, federally managed to total forest in State	Average cost per acre	Total cost of perchase and relation to total expenditure	
	Number	*Acres*	*Acres*	*Percent*	*Acres*	*Percent*			*Percent*	*Acres*	*Acres*	*Percent*			*Percent*
Gulf and Southeast:															
Florida	3	792, 842	584, 795	2. 48	236, 229	5. 00	$3. 95	$931, 967. 73	4. 40	138, 331	723, 126	3. 06	$3. 53	$488, 688. 50	2. 74
Louisiana	3	315, 572	61, 275	. 32	61, 275	1. 29	4. 02	246, 044. 62	1. 16	222, 700	283, 975	1. 49	3. 00	667, 355. 00	1. 77
South Carolina	2	175, 000	----------	--------	----------	--------	--------	----------	--------	175, 000	175, 000	1. 38	6. 00	1, 050, 000. 00	2. 03
Regional total	8	1, 283, 414	646, 070	. 46	297, 504	6. 29	3. 96	1, 178, 012. 35	5. 56	536, 031	1, 182, 101	. 85	4. 12	2, 206, 043. 50	6. 54
Lake States:															
Michigan	4	1, 401, 407	687, 009	3. 35	335, 404	7. 09	1. 73	581, 450. 07	2. 74	795, 411	1, 482, 420	7. 23	2. 50	1, 988, 527. 00	4. 96
Minnesota	2	1, 884, 610	943, 969	4. 31	131, 555	2. 79	1. 79	234, 856. 58	1. 11	408, 199	1, 352, 168	6. 17	2. 50	1, 020, 497. 00	2. 43
Wisconsin	6	1, 257, 974	237, 200	1. 36	235, 134	4. 97	1. 60	376, 035. 29	1. 77	728, 833	966, 033	5. 55	2. 50	1, 822, 080. 00	4. 25
Regional total	12	4, 543, 991	1, 868, 178	3. 12	702, 093	14. 85	1. 70	1, 192, 341. 94	5. 62	1, 932, 443	3, 800, 621	6. 36	2. 50	4, 831, 104. 00	11. 64
Total timber units	20	5, 827, 405	2, 514, 248	1. 26	999, 597	21. 14	2. 37	2, 370, 354. 29	11. 18	2, 468, 474	4, 982, 722	2. 50	2. 85	7, 037, 147. 50	18. 18
Grand total	41	16, 523, 858	7, 231, 555	2. 15	4, 727, 680	100. 00	4. 48	21, 203, 021. 93	100. 00	7, 639, 742	14, 871, 297	4. 42	4. 05	30, 959, 479. 55	100. 00

In order fully to accomplish the purposes for which these units were created, the Federal Government should further acquire within their boundaries a total of approximately 5,171,268 acres. On the basis of past values this area would cost approximately $23,922,332, or an average of $4.65 per acre, but present price trends indicate that the actual cost would be substantially lower, probably not exceeding $20,000,000. If the program were carried out in full the Federal Government within the 21 units would then control 9,888,575 acres, at a total purchase cost of something less than $39,000,000.

The stimulation of timber production as a Federal function in the Eastern States is not wholly a process of large scale direct ownership and management of land but also one of research, experimentation, and demonstration. These purposes can be accomplished with administrative units smaller than the areas required where watershed protection is the objective. To date, 20 timber-production units have been established in 6 different States, but 2 of those States also contain watershed units so that the total number of States affected is 20. Within the 20 established timber-production units the United States now controls 2,514,248 acres; of which 999,597 acres have been acquired by purchase at a total cost of $2,370,354.29, or an average of $2.37 per acre. To complete the 20 existing units an additional area of about 2,468,474 acres should be acquired; at a cost of $7,000,000. If that were done, the total area under Federal control in the 20 established units would be 4,982,722 acres; for which something less than $10,000,000 would have been paid.

The statements contained herein relate only to the completion of the existing national forests to a point where their public objectives and values can be fully realized within reasonable limits of administrative cost. They present only a partial and incomplete picture of future requirements. The economic facts which seem indubitably and imperatively to dictate the enlargement of many of the existing national forests and the establishment of many others are set forth in another section of this report, which presents in detailed terms of distribution, area, and cost the apparent ultimate scope of the national-forest system.

A considerable part of the lands which will be proposed for acquisition are in the Pacific coast and northern Rocky Mountain regions. The facts stated in the fore part of this section make it evident that the passage of such lands to Federal ownership, under conditions fair and equitable both to the public and to the landowners, would in large measure relieve a situation which while originating in a somewhat limited territory is national in its ultimate consequences. The program which will be proposed, therefore, would not be antagonistic to the best interests of the private owner of forest lands but, on the contrary, would be in complete accord with the evident trend of land economy and forest economy.

Lands acquired in the Eastern States would not contain the large volumes of stored-up timber characteristic of the Western States. The effect of their acquisition would not be to relieve private owners from an accumulation of past burdens, but to afford such owners better opportunities for progress and profit in the future operation of the forest properties suitable for private management, by supplementing the production of such properties, by affording means for better developing and demonstrating best principles of forest management, and by contributing to the systematic control of fire, disease, and insects. By making the national-forest units centers of research, experimentation, demonstration, and constructive cooperation, the Federal Government will not only meet those phases of the forest problem which are national in their implications and consequences but will also create conditions more favorable to the private practice of forestry.

STATE AID TO PRIVATE OWNERS AND LOCAL POLITICAL UNITS

By H. J. Eberly, District Forest Inspector

Page
Scope and functions of State aid ---- 1177
Analysis of State aid by projects ---- 1179
Analysis of State aid by regions ---- 1185

SCOPE AND FUNCTIONS OF STATE AID

Ownership of the 495 million acres of commercial forest land in the United States is divided as follows:

	Percent
Federal	18
State, county, and municipal	2
Private	80

Since 80 percent of our total commercial forest area is in private ownership, embodying a vast amount of public interest and welfare, it is readily apparent that public participation to aid and stimulate private action in forestry is desirable and offers great possibilities of getting something done on an immense forest area. For example, of the total area of privately owned commercial forest lands in need of protection from fire, only a little better than half is at present being protected.

The Federal Government offers forestry aid in fire protection, planting, and extension work to private owners through the States under the provisions of the Clarke-McNary law. Likewise the several forested States extend aid to private forest owners, and this discussion is for the purpose of evaluating the amount of such aid and of presenting factual information on the character of such activities.

All the States, except Arizona, Missouri, and South Dakota, now provide many or all of their private forest landowners with some form of forestry aid. Some States are doing much, others comparatively little, but the basic need and justification of extending aid to private forest owners are given at least formal acknowledgment by all forested States. In some instances aid in forestry is extended by counties, towns, and municipalities as well as directly by the State, and in this report all such aid is included as "State aid."

The character of State aid to private owners is along one or more of the following well defined lines of forestry activity: Protection from forest fires, planting and nursery work, forestry extension, tree disease control, forest insect control, legislation, research, economic and forest surveys.

It is to be understood that these services, or the part considered here, are those which are performed or financed directly by State (or local) governments and which extend outside the boundaries of publicly owned lands and accrue to the benefit of the private owner.

State forestry aid, according to its character, may be of direct or indirect assistance to the private owner. Thus, in fire protection, owners receive direct aid through State forces or State funds which help them to bear the cost of protecting their holdings, while the results of research aid indirectly by providing information that may or may not be applied by the individual owner in the improvement of forest practice and returns.

An effort has been made to ascertain the amount of State, county, and town funds annually spent for forestry work which aids forest owners, and the results are shown by regions in tables 1 and 2. On account of the great difficulties encountered in obtaining these data, absolute exactness is not claimed. The most that can be said for the tables is that they represent the most comprehensive survey yet made in this field. Wide variations in the character and organization of the many State forestry projects, added to the complexities of evaluating indirect aid, all contribute to the difficulties of expressing definitely the monetary value of all aid rendered. The findings must be interpreted under these limitations, which are explained more fully in the discussion of the various projects.

This discussion will deal first with the broader aspects of State aid being developed under the eight forestry activities of projects, with incidental consideration as to regions and States. Following this a more detailed analysis of activities within the regions will be presented.

TABLE 1.—*Amount of State, county, and town funds expended annually, and character of projects, of State aid in forestry extended to private owners, by regions*

Region	Fire protection[1]		Planting and nursery[2]		Forestry extension[3]		Tree disease control[4]	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
New England	354, 929	11. 1	40, 656	11. 3	10, 392	11. 2	106, 126	43. 2
Middle Atlantic	863, 743	27. 0	180, 512	50. 1	17, 757	19. 2	94, 707	38. 5
Lake	1, 246, 361	38. 9	10, 633	3. 0	16, 287	17. 6	9, 404	3. 8
Central	121, 520	3. 8	73, 628	20. 5	15, 883	17. 1	--------	--------
South	313, 341	9. 8	25, 339	7. 0	24, 324	26. 2	--------	--------
Pacific Coast	298, 097	9. 3	17, 372	4. 8	3, 271	3. 5	35, 750	14. 5
North Rocky Mountain	--------	--------	6, 349	1. 8	2, 004	2. 2	--------	--------
South Rocky Mountain	2, 867	. 1	5, 467	1. 5	2, 800	3. 0	--------	--------
United States	3, 200, 858	100. 0	359, 956	100. 0	[5] 92, 718	100. 0	245, 987	100. 0

Region	Forest insect control[6]		Forest research[7]		Economic and forest surveys		All activities	
	Dollars	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*
New England	[6] 1, 129, 539	85. 6	5, 000	2. 8	--------	--------	1, 646, 642	30. 2
Middle Atlantic	[8] 182, 164	13. 8	55, 120	31. 4	--------	--------	1, 394, 003	25. 6
Lake	--------	--------	43, 260	24. 6	41, 000	81. 2	1, 366, 945	25. 1
Central	--------	--------	12, 000	6. 8	--------	--------	223, 031	4. 1
South	--------	--------	15, 913	9. 1	--------	--------	378, 917	7. 0
Pacific Coast	[8] 7, 734	. 6	31, 500	17. 9	9, 500	18. 8	403, 224	7. 4
North Rocky Mountain	--------	--------	13, 000	7. 4	--------	--------	21, 353	. 4
South Rocky Mountain	--------	--------	--------	--------	--------	--------	11, 134	. 2
United States	1, 319, 437	100. 0	175, 793	100. 0	50, 500	100. 0	5, 445, 249	100. 0

[1] From Forest Service compilations, fiscal year 1932.

[2] From Forest Service compilations, calendar year 1931.

[3] From compilations of the Forest Service, and other sources.

[4] Information obtained from Bureau of Plant Industry, fiscal year 1932.

[5] The States report an additional $15,000 devoted to broad activity of forestry extension but not specifically so designated. More than this may actually be spent.

[6] Information furnished by Plant Quarantine and Control Administration, fiscal year 1932.

[7] Information obtained from various sources, fiscal year 1932.

[8] Calendar year 1931.

Table 2.—*Annual distribution of State, county, and town funds among projects of State aid extended private owners, by regions*

Project	New England	Middle Atlantic	Lake States	Central States	South	Pacific coast	North Rocky Mountain	South Rocky Mountain	All regions
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fire protection	21.6	62.0	91.2	54.5	82.7	73.9	--------	25.8	58.8
Planting and nursery	2.5	12.9	.8	33	6.7	4.3	29.7	49.1	6.6
Forestry extension	.6	1.3	1.2	7.1	6.4	.8	9.4	25.1	1.7
Tree disease control	6.4	6.8	.7	--------	--------	8.9	--------	--------	4.5
Gypsy moth and other forest insect control	68.6	13.1	--------	--------	--------	1.9	--------	--------	24.3
Forest research	.3	3.9	3.1	5.4	4.2	7.8	60.9	--------	3.2
Economic and forest surveys	--------	--------	3.0	--------	--------	2.4	--------	--------	.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

ANALYSIS OF STATE AID BY PROJECTS

Table 3 presents the present annual expenditures for State aid to private owners in the entire United States, according to the data available, as distributed among the several forestry activities.

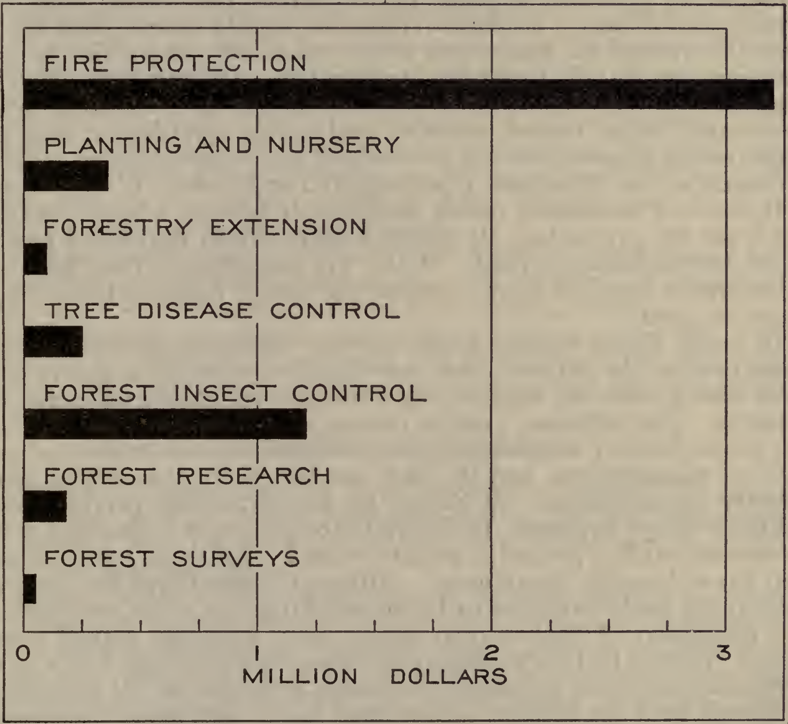

Figure 1.—Amount of State aid in forestry extended annually to private owners, by character of projects.

The following amounts are net State, county, and town expenditures for aid to private forest owners and do not include those of private owners or cooperative Federal allotments. Figure 1 graphically illustrates the amount of State aid in forestry extended annually to private owners by character of the forestry projects.

TABLE 3.—*Annual State aid in forestry to private owners, by projects*

Project	Amount supplied	
	Dollars	Percent
Fire protection	3, 200, 858	58. 8
Planting and nursey work	359, 956	6. 6
Forestry extension	92, 718	1. 7
Tree-disease control	245, 987	4. 5
Forest-insect control	1, 319, 437	24. 3
Forest research	175, 793	3. 2
Economic and forest surveys	50, 500	. 9
Total	5, 445, 249	100. 0

FIRE PROTECTION

The greatest amount of State aid in forestry being provided private owners in the entire Nation is for forest fire protection. This amounts to over $3,000,000 annually and constitutes approximately 60 percent of the total.

Fire protection embraces the employment, organization, and supervision of all personnel engaged in preventing, discovering, and suppressing forest fires. It likewise provides for all publicity and educational efforts and the equipment used for teaching the public the need and importance of forest-fire prevention. To fire protection is charged the cost of lookout towers, telephones and telephone lines, roads and trails, horses, vehicles and motor equipment, and the employment of personnel and purchase of any equipment and supplies necessary to the detection, reporting, and suppression of forest fires.

It does not necessarily follow that, simply because a State provides funds for fire protection, all timber owners within that State receive direct benefit from such aid. Where fire protection is established on a State-wide basis, all private owners do receive direct aid from State funds so spent.

In many States limited funds prevent organized protection on a large part of the private lands needing fire protection, and in such cases direct State aid reaches only those owners within the protected districts. Nevertheless, outside owners receive indirect aid through the broad forestry educational programs and demonstrations of protection, management, and the like, conducted by the central State forestry organization. All States having important private forest holdings except Arkansas, Idaho, and Montana, now extend aid in fire protection to all or groups of private owners. Arkansas has no organized State forestry department. Although State funds for fire protection are made available in Idaho and Montana, these are spent for the protection of State-owned rather than privately owned forest lands. Except in Illinois, which provides fire protection funds independently, all State organized protection activities are on a cooperative basis with the Federal Government under provisions of section 2 of the Clarke-McNary law.

The Lake region, embracing Michigan, Minnesota, North Dakota, and Wisconsin, ranks first in the Nation in the amount of State funds provided for fire protection and suppression. The Middle Atlantic region ranks second and New England third.

The Lake, New England, and Middle Atlantic regions also rank high in the proportional amount of State aid extended in the fire-protection project. In this respect they differ materially from the Western States, whose laws require the owner to make the principal provisions for the protection of his lands from fire.

FOREST PLANTING AND NURSERY WORK

Planting and nursery work pertains to the establishment of forest-tree nurseries, the collection and purchase of seed, the growing of forest seedlings, and the distribution of forest planting stock by the States to the private forest landowner. The distribution is now primarily for the benefit of the farmer owner, and in most States the planting stock is furnished by the States at cost of production. In this discussion the planting by the States of their own forest lands is not included.

Of the total State aid extended all private owners in forestry, 6.6 percent is for some form of planting and nursery work. Thirty-eight States are providing aid of this general description with a present annual State contribution of approximately $360,000. The extent and character of the aid rendered varies according to local problems. All are cooperating with the Federal Government under section 4 of the Clarke-McNary law in providing aid in the procurement, production, and distribution of forest-tree seeds and plants for the purpose of establishing windbreaks, shelter belts, and farm woodland. Approximately one half of the total financial aid in planting benefits the farmer. Commercial planting of cut-over lands by private owners and the planting of State forest areas are also directly or indirectly aided—directly by the production of cheap nursery stock and indirectly by advice as to planting methods.

From a national viewpoint the Middle Atlantic region ranks first in the amount of aid extended by States to private owners in planting, with the Central States second and New England third.

While State funds spent for planting and nursery work are in part returned to the States through the sale of planting stock to private owners, the planting expenditures herein reported are exclusive of sales receipts.

FORESTRY EXTENSION

Forestry extension includes all public efforts through information, advice, and demonstrations to promote among private forest owners, particularly farm owners of woodlands, the proper care and use of their forest-growing lands.

In most States forestry extension aid to farm timberland owners is provided in cooperation with the Federal Government under the provisions of section 5 of the Clarke-McNary law. In addition to the 31 States cooperating on this basis with their farmers, Maine independently provides direct extension aid to farmers, and Florida does likewise for naval stores operators. State aid in forestry extension to private owners as shown in tables 1 and 2 includes only those expenditures made on projects organized and conducted primarily for such work. On this basis, present annual expenditures for extension activities constitute 1.7 percent of total State-aid expenditures, a low rating. No attempt has been made to evaluate allocated part-time activities of State forestry employees performing principally other duties.

Extension work, which comprises demonstrations of desirable forest management practices and the furnishing of advice as to thinnings, management, and care of private timber-growing projects, is a form of indirect State aid. During the fiscal year 1931 Wisconsin ranked first among the States with an expenditure of $9,199 for forestry extension work, Pennsylvania second with $8,657, and Georgia third with $6,080.

TREE DISEASE CONTROL

During the fiscal year 1932 the States made $245,987 available for forest-tree disease control for the aid of private owners. The work financed by States was confined to the New England, Middle Atlantic, Lake, and Pacific coast regions and was specifically for pine-blister-rust control. This rust affects only five-needle pines, so that control work is not needed outside the regions where these species grow. Control consists in the eradication of gooseberry and black-currant bushes, the intermediate host of the rust fungus.

Of the total amount made available the States appropriated and allotted $196,282 and towns $49,705. In the north Rocky Mountain region (Idaho and Montana) $30,000 of State money was made available but this amount is not included in the total as an aid to private owners because it was spent on State rather than privately owned lands. The annual State tree-disease control expenditures in behalf of private owners amounts to 4.5 percent of all State aid expenditures for forestry in the United States.

GIPSY MOTH AND OTHER INSECT CONTROL

Forest insect control embraces all efforts by spraying, dusting, the breeding and release of parasites, or otherwise, to combat forest insect pests. Direct State aid in insect control at present is centered on the control of the gipsy moth, a tree-defoliating insect which has caused great loss in the northeastern region of the United States.

Large sums have been made available by States in the New England region and by New Jersey and New York for the control of this destroyer. The Federal Plant Quarantine and Control Administration reports the expenditure during the fiscal year 1932 by six States and during the calendar year 1931 by two States of $1,311,703 from State, county, and town funds.

Control barriers are established within forest areas to prevent spread of the defoliating insects, but a very considerable portion of the funds is devoted to spraying and dusting along roadsides and some for work on shade trees. Since all types of work combine to aid in preventing spread of the disease to commercial forest areas, the entire expenditure as reported has been included in tables 1 and 2 as State aid to private forest owners.

Only one other forest insect control project in 1931 is part of the present record. In Washington the State, county, and private forest interests combined to finance a $15,000 project which is described in the latter part of this section. This makes the imposing total for the Nation of $1,319,437 spent for forest insect control work by the States as an aid to private owners, or 24.3 percent of all State aid expenditures for forestry in the United States. The northeastern group contributed practically all of this, as follows:

	Percent
New England	85. 6
Middle Atlantic	13. 8
Pacific coast	. 6
Total	100. 0

Other forms of forest insect control work are being conducted in the Western States, but there the funds are raised by the private owners under State legislation, and no direct State moneys are provided.

LEGISLATION

Legislation, as here considered, has reference to State enactments redounding to the advantage of forestry and forest ownership. Features of certain forest or forest land taxation laws may properly be considered as an important form of State aid to private owners. Forest taxation will be discussed here and in part II only briefly, because the whole subject will be covered in the forthcoming taxation inquiry report.

Twenty States have enacted legislation granting tax relief to forest lands regardless of the origin or area of the stand. Louisiana, Wisconsin, and Oregon have the greatest acreage listed under such legislation. Fourteen States have laws granting tax relief to planted stands, to limited areas, or to properties leased or deeded to the State. It is deemed impracticable to evaluate financially this form of State aid, and therefore no monetary aid is shown under this head.

RESEARCH

Research includes scientific studies, wherever performed, the cost of all or part of which is defrayed by the State, to determine the life history of trees, factors and conditions affecting their establishment, growth, utilization, etc.

State funds allocated to forest research projects are generally productive of indirect aid to private forest owners, the value of the results depending entirely on individual use of them. Information as to State funds spent for forest research is incomplete, but the amount ascertainable was in the neighborhood of $175,793 during the fiscal year 1932, or 3.3 percent of all State funds expended for forestry as a means of private aid.

Few States conduct extensive forest research projects of their own, although many devote attention to local forest problems incidental to other forestry work. These minor research contributions are mostly in the form of allocated time, and no attempt has been made to have them evaluated. States which are outstanding in conducting specific forest research projects are Pennsylvania, New Jersey, New York, Minnesota, and Georgia. Several States contribute funds to outside agencies, as in California, where the State allots funds for research to the Federal Forest Experiment Station. Several other States including Idaho, Indiana, Michigan, and California are expressing their interest in research by making funds available for such work in their educational institutions of higher learning.

Several forest schools at other State institutions conduct research projects and contribute materially to forestry knowledge, but data are lacking as to the exact amount of such work and the portion which constitutes a form of State aid to private owners.

FOREST AND ECONOMIC SURVEYS

In order to plan an adequate forestry program intelligently it is of greatest importance that a State know the character and extent of its forest lands and resources. Some States are taking steps to inventory their forest lands and resources. The Federal Government is engaged in a project of this kind which contemplates a survey covering all forested States in the Nation. The Lake States of Michigan, Minnesota, and Wisconsin have undertaken land economic surveys of their own to find out the present character and use of wild lands and to aid in determining the best use of such areas for permanent development. This economic inventory is still under way in Michigan and Wisconsin but has been temporarily discontinued in Minnesota. Of the total amount spent, $41,000 is estimated here as the 1932 fiscal year expenditure by the State on forest land surveys in aid of private owners. These economic surveys are of principal value and are of direct aid to the States themselves in formulating public policies and programs. The aid of these surveys to private owners is of very indirect nature and it is therefore difficult to set a true valuation of such aid to them.

In California the State in 1932 contributed approximately $9,500 for a forest-cover map, and this amount is included as a State-contributed aid to private forest owners. Both Oregon and Washington have allotted small amounts to the Federal forest survey, primarily for the preparation of forest-cover maps. The total amount of money listed under the present heading is $50,500, which represents the Lake States and California items. Several other States, in the past and in various manners, have conducted surveys or inventories of their forest resources, but the work has seldom been complete. There is a distinct need for more work of this nature.

SUMMARY

The following recapitulation shows the regional distribution of annual expenditures for State aid:

	Percent		*Percent*
New England	30. 2	Pacific Coast	7. 4
Middle Atlantic	25. 6	North Rocky Mountains	. 4
Lake	25. 1	South Rocky Mountains	. 2
Central	4. 1		
South	7. 0	Total	100. 0

Figure 2 shows by regions and figure 3 by States, the total amount of State aid in forestry extended anually to private owners for all projects. To give some idea of the size of areas needing aid in each region, this amount is contrasted with the area of privately owned forest lands in need of protection from fire. Since certain States materially promote accomplishments in fire protection through legislation affecting private owners, this graph includes also the amounts expended by all private forest owners for fire protection. The amount of acreage as shown in need of protection from all types of damage is not in itself a true and complete index of the amount of State aid which it would be proper for the regions to provide. The costs per acre of forestry work, particularly fire protection, varies very materially between the different regions, and cost rather than acreage is the true standard of comparison.

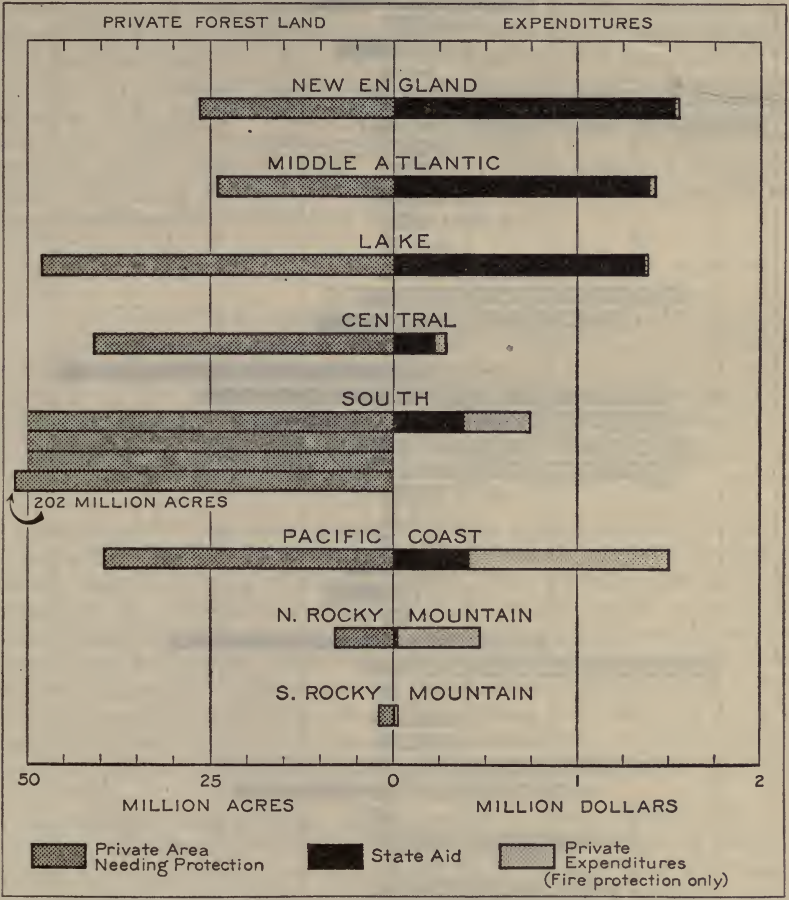

FIGURE 2.—Regional summary of State aid in forestry extended annually to private owners for all characters of projects, and private expenditures reported by States for fire protection, compared with privately owned area needing fire protection.

ANALYSIS OF STATE AID BY REGIONS

NEW ENGLAND REGION

The New England region comprises the States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. The total State aid, including county and town expenditures, in this region is listed in table 4.

State aid extended owners in this region amounts to 30.2 percent of all State aid extended in the United States and ranks first among regional expenditures.

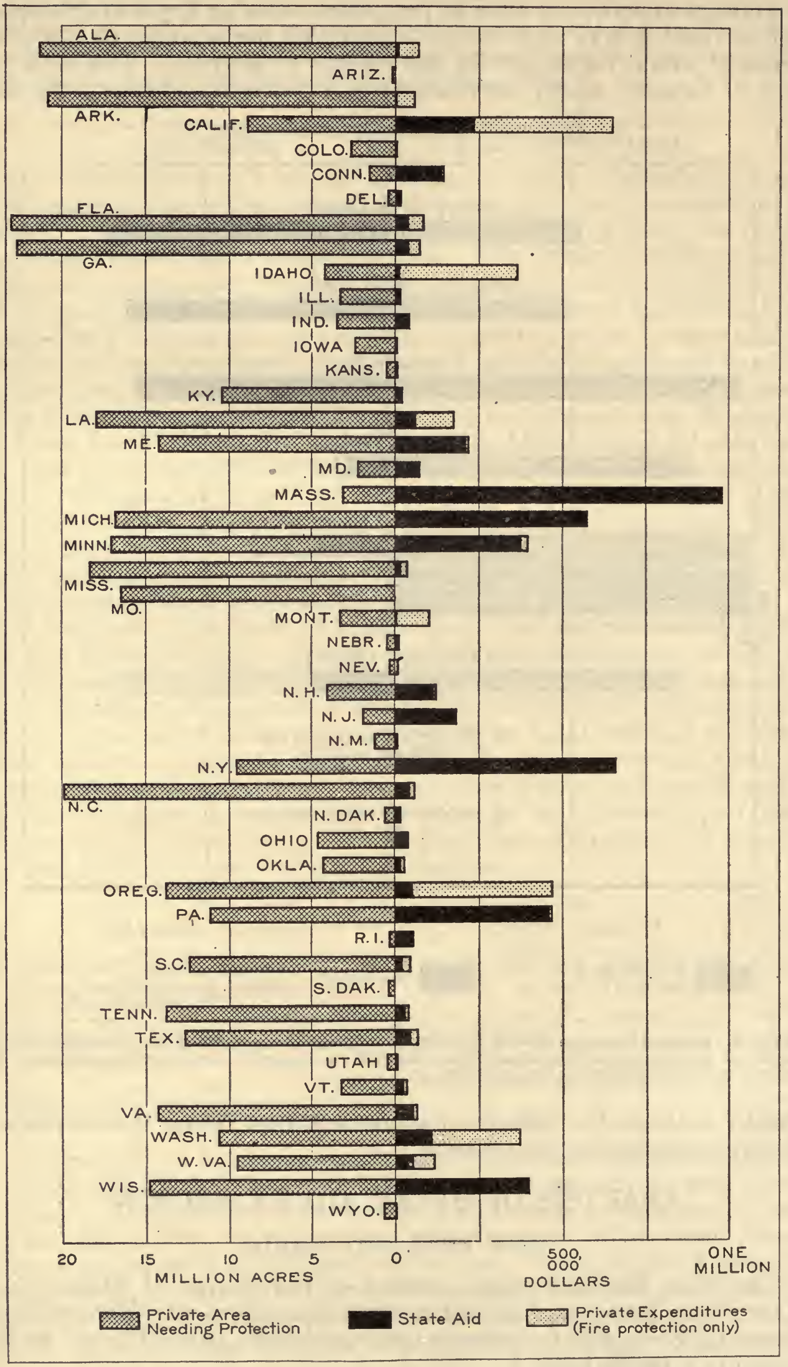

FIGURE 3.—Amount of State aid in forestry extended annually to private owners for all characters of projects, and private expenditures reported by States for fire protection, compared with privately owned commercial forest area.

Fire protection.—State, county, and town aid provided in the fiscal year 1932 for fire protection amounted to $354,929 in the six New England States. The protection afforded is State-wide, and all private forest owners receive direct public aid from either State, county, or town funds. In Maine a special fund for fire protection on part of the area is raised by a levy of 2¼ mills on the valuation of all property, while on the remainder of the area towns pay suppression costs and the State and Federal Governments carry the costs of prevention. In Massachusetts and Vermont the entire costs of suppression, and in New Hampshire and Rhode Island half of these costs, are town obligations. In Connecticut half the suppression costs are paid by the counties. In Connecticut there is a small association of private owners, but the general practice in this region is to protect private timberlands at public expense.

TABLE 4.—*Annual State aid to private owners in New England, by projects*

Project	Distribution of regional aid	
		Percent
Fire protection	$354,929	21.6
Planting and nursery work	40,656	2.5
Forest extension	10,392	.6
Tree-disease control	106,126	6.4
Gipsy-moth control	$1,129,539	68.6
Forest research	5,000	.3
Total	1,646,642	100.0

Planting.—All the New England States except Rhode Island own and operate tree nurseries, and all extend aid to farmers in planting. Rhode Island solicits planting orders from owners and purchases seedlings in wholesale quantities from commercial nurserymen. Massachusetts ranks first in this region in the number of forest trees distributed to farmers which in 1931 amounted to more than half a million. Some 2½ million more are planted annually in the State, with about 2 million going on State forests and 600,000 on water companies' lands and other large private holdings. Planting on the State forests and on water company holdings are reported as nearing completion.

Extension.—Connecticut, Massachusetts, New Hampshire, and Vermont all extend State aid to owners of farm woods and are cooperating with the Federal Government under section 5 of the Clarke-McNary law. New Hampshire and Connecticut are especially active in this extension aid. Maine employs its own extension forester, who performs both extension and educational work.

Blister-rust control.—The States in this group provide more money for the control of white pine blister rust than for either planting, extension, or research activities. New Hampshire leads all other States in the amount provided for this tree disease control work, expending in the fiscal year 1932, $55,000.

Gipsy-moth control.—Still larger sums are made available for gipsy-moth control. During the fiscal year 1932 the six States of New England, together with their counties and towns, contributed $1,129,539 to suppress this insect. In Massachusetts alone the sum of $803,048 was provided. State, county, and town aid for the work comprises 68.6 percent of the regional expenditures for all forms of forestry aid to private owners.

Research.—A sum of approximately $5,000 is provided by this group of States for aid in forest research. Massachusetts performs research work on the Swan State Forest. Forestry departments and educational institutions of the other States are engaged in a limited amount of silvical research. Entomological research work is worthy of note in Maine and Connecticut. There is a growing demand in this region for Federal aid through research on the economic phases of forestry.

MIDDLE ATLANTIC REGION

The States in this group comprise New York, New Jersey, Pennsylvania, Delaware, and Maryland.

Annual expenditures for State aid to private owners is segregated, by projects, in table 5.

Expenditures for State aid in this group constitute 26.1 percent of those made in the entire Nation and are only exceeded by those in the New England region.

Fire protection.—State aid in fire protection amounted to $863,743 during the fiscal year 1932, and giving this group second rank in the Nation in such aid averaged over the past 5 years. By far the greater proportion of the whole expenditure is for aid to private owners, although State forests as well as private holdings are protected. Pennsylvania and New York provide the greatest amount for State aid in fire protection, the former contributing $371,996 and the latter $281,743 during the fiscal year 1932. The greatest amount spent in any one year during the past 5 years by any one State in this group of five was $574,361 by Pennsylvania during the calendar year 1930. Since with minor exceptions fire protection is conducted on a State-wide basis, practically all forest owners receive this aid. Furthermore, practically all costs of protection are borne by public rather than private agencies. In Maryland one half the costs of fire suppression are paid by the counties.

TABLE 5.—*Annual State aid to private owners in Middle Atlantic region, by projects*

Project	Distribution of regional aid		Project	Distribution of regional aid	
		Percent			*Percent*
Fire protection	$863, 743	62. 0	Gipsy-moth control	$182, 164	13. 1
Planting and nursery work	180, 512	12. 9	Forest research	55, 120	3. 9
Forest extension	17, 757	1. 3			
Tree-disease control	94, 707	6. 8	Total	1, 394, 003	100. 0

Planting.—The Middle Atlantic States far exceed any other group in State aid extended in forest planting and nursery activities. During the calendar year 1931 they provided $180,512 for aid in private planting projects. Of the total amount of State planting aid extended by all States to private owners, this group contributes more than half. In 1931 New York in aiding private planting projects alone spent $113,136 of State funds, amounting to more than 30 percent of the total of State planting aid in the entire Nation. Large additional amounts were spent by Pennsylvania and New York for planting on State-owned forest areas.

Extension.—Slightly more than 1 percent of the total State aid in this region is in the form of forestry-extension work. All the States, except Delaware, employ extension workers and are furnishing State aid of this nature in cooperation with the Federal Government under provisions of the Clarke-McNary law. Pennsylvania led in 1931 with an expenditure of $8,657 and New York ranked second with $5,020. New York, in addition to the extension forester's activities, furnished extension service to private owners through aid of members of Cornell, Syracuse, and St. Lawrence Universities. The limited amount of forestry-extension work needed in Delaware does not warrant the employment of a man solely for this duty, but incidental work in extension is performed.

In New Jersey the extension forester aids owners of small timber tracts by making general surveys of the properties, marking small sample areas for selective cutting, and furnishing information in marketing forest products. For projects that require only a few days of field work the aid is furnished free to owners. For partial estimates on larger tracts the State charges owners for the forester's field expenses.

In Pennsylvania the Department of Forests and Waters gives free advice to private owners, and particularly to water and mining companies, on forest management, but the extension work among farmers is not stressed, owing probably to the strong farm-forestry extension activities of the Pennsylvania State College of Forestry.

Maryland tenders forestry-extension service to private owners through the aid of both the extension forester and members of the State Department of Forestry. Information is given on timber estimating, sample marking, preparation of sale contracts, and prospective buyers. The foresters charge the owners $3 per day plus expenses up to 3 days' service, and thereafter at rate of $8 per day. In 1929 examinations were made and plans formulated for 50 forest properties comprising 13,500 acres of woodland located in 18 different counties.

Blister-rust control.—During the fiscal year 1932 New Jersey, New York, and Pennsylvania spent $94,707 of State money for white pine blister-rust control. This amount, while it comprises only 6.8 percent of the total amount of State forestry aid in the Middle Atlantic group, was 38.5 percent of all State aid in the Nation for its specific purpose. New York contributed most of the funds, putting up $75,000. Delaware does not contain white pine, and the limited areas of such species in Maryland do not apparently necessitate control work.

Gipsy-moth control.—State aid for gipsy-moth control was made available by New Jersey and New York during the calendar year 1931 in the amount of $182,164. This amount comprises 13 percent of the State aid of all forms rendered by all five States to private owners.

Research.—In these States some technical employees of the forestry organizations devote a portion of their time to research, but only in New Jersey, New York, and Pennsylvania is this activity provided for in definite form. Expenditures for research by all three States during the fiscal year 1932 are estimated at $55,120, or 4 percent of all State forestry-aid expenditures in the entire group. In Pennsylvania the Department of Forests and Waters maintains a Forest Research Institute at Mont Alto and allots annually approximately $21,120 for research activities. In New Jersey considerable research has been done along the lines of growth studies and the preparation of volume tables. New York contributes more toward forest research than any of the other States in the group. The New York State forestry department is active in research, and in addition the State budget provides aid in research through funds allotted the State forest schools at Syracuse and Cornell. New York's State aid in research amount annually to approximately $31,000.

Of the total amount of State aid provided in the Nation for forest research, 31.4 percent comes from the Middle Atlantic group of States.

LAKE STATES REGION

The States in this group comprise Michigan, Minnesota, North Dakota, and Wisconsin. Annual expenditures of State aid to private owners is segregated by projects in table 6.

Fire protection.—State aid in expenditures for fire protection in this group of States is outstanding in that the amount exceeds that in any other group and constitutes 38.9 percent of the total State fire-protection expenditures in all groups. During the 5-year period 1927–31, Michigan, Minnesota, and Wisconsin together made an average annual expenditure of $941,804 for fire protection. Michigan leads in the amount of these State expenditures, having spent during the fiscal year 1932, $523,799 with Minnesota and Wisconsin each spending approximately $370,000. The greatest amount of State aid provided by any one State in any single year during the past 5-year period was by Michigan in 1930, in the amount of $708,086.

These three States own State forests, parks, public domain, and tax-delinquent forest lands amounting to several million acres, and in the protection expenditures allowance must be made for fire protection on these as well as on privately owned forest properties. From 1924 to the end of the fiscal year 1932 Federal, State, and private expenditures for fire protection in the three States have aggregated $8,439,202, segregated as follows:

	Amount	Percent
State funds	$6, 881, 666	82
Private funds	118, 390	1
Federal funds	1, 439, 146	17
Total	8, 439, 202	100

The States themselves are taking leadership in fire-control work. Private owners do not contribute funds for forest-fire protection in Michigan and Wisconsin. In Minnesota, where the present private contribution is but 5 percent of the total, financial cooperation from owners is becoming less each year as the commercial forests are harvested. Steady advancement has been made in State participation by all three States, and increases in the States' budgets for fire control have been made from year to year.

All forest land within the protection districts in Michigan, Minnesota, and Wisconsin is now being more or less thoroughly protected. It amounts to 55,811,030 acres in the aggregate and is 100 percent of the forest area now estimated as in need of being protected. Hence all private owners may be said to receive direct aid in this respect. More or less pressure is being brought to bear upon all three States to extend the protection districts to include regions to the south and also to give more intensive protection to certain areas within the existing districts.

Planting.—Planting and nursery work is maintained in Wisconsin with the State conservation department; in Michigan, with the State college; and in North Dakota, with the State forester. Because of legislative limitations, no such cooperative planting work is conducted in Minnesota. Eventually Minnesota may be led to take advantage of Federal cooperation by the increasing demand of farmers for forest planting stock. The State has recently established a nursery and during 1932 expects to plant a million trees on State-owned lands largely by contributed time of employees within its forestry organization.

TABLE 6.—*Annual State aid to private owners in the Lake States, by projects*

Project	Distribution of regional aid	
		Percent
Fire protection	$1,246,361	91.2
Planting and nursery work	10,633	.8
Forestry extension	16,287	1.2
Tree-disease control	9,404	.7
Forest research	$43,260	3.1
Economic surveys	41,000	3.0
Total	1,366,945	100.0

During the calendar year 1931 the States of Michigan, Wisconsin, and North Dakota made $13,824 of State funds available for planting work. Of this amount approximately $10,633 benefited private forest land owners in their planting enterprises. This extended expenditure is 3 percent of planting aid extended by all States, but it constitutes only 0.8 percent of the expenditure for all financial aid in forestry within the Lake group.

From 1926 to 1931 Wisconsin, Michigan, and North Dakota have produced and distributed 18,129,189 trees to private owners, about half going to farmers and half to larger holdings.

In Michigan two agencies are engaged in forest tree nursery work with a total annual production and distribution of nearly 24 million trees for planting on State and private lands. The conservation department produces stock primarily for planting on State-owned lands and the State college for distribution to the farmers and other private owners. The year 1931 probably represents a peak in the public planting operations. The conservation department produced in that year more than 22 million trees, of which over 21 million were planted on State land. The total production and distribution of planting stock in Michigan was exceeded in 1931 by only one other State, namely, New York.

The Michigan State College, cooperating with the Federal Government under the Clarke-McNary law, distributed in 1931 nearly 1½ million seedlings and transplants to private owners and produced 7,140 trees for planting on State lands. The total distribution of trees to farmers in Michigan increased from 268,376 in 1925 to 1,726,926 in 1931. In 1931, 158 farm windbreaks were established.

In 1931 the Wisconsin forestry program received greatly increased financial support. Increased planting programs on State forest lands are planned. Moreover private lumber, pulp, and paper companies in Wisconsin are becoming more interested in planting. One company in 1931 planted 1,896 acres. Some companies are developing nurseries of their own.

An urgent planting need exists in the Lake States, both on privately owned and on State and county lands. The development of State and county forests and the reforestation of lands being entered under the forest crop laws, especially in Michigan and Wisconsin, will necessitate planting on an immense scale.

Extension.—All four States employ extension foresters in cooperation with the Federal Government. During the fiscal year 1931 they expended $16,287 on cooperative extension projects of aid to private forest owners, especially to farmers for the furtherance of better forestry practice. This extension work has resulted in an increase in farm forest planting. Windbreaks and shelter belts have been established, woodlands improved, and boys and girls encouraged in forestry through 4–H Club work. The forestry department of the University of Michigan, Michigan State College, and the University of Minnesota also furnish free information and technical advice to owners in regard to the proper management of forest lands. This includes not only correspondence and interviews but often the examination of areas and, in some cases, the preparation of management plans.

Blister-rust control.—During the fiscal year 1931 the Lake States made available for white pine blister-rust control $9,404 which constitutes a direct aid to certain white-pine owners. Blister-rust control in Michigan, Minnesota, and Wisconsin is organized on a cooperative basis between the Federal Government through its Division of Blister Rust Control, the State agency, usually the department of conservation and/or the department of agriculture, and owners of white pines. Each owner of white pines desiring protection against blister rust furnishes the necessary labor to eradicate currant and gooseberry bushes under direction of a foreman furnished by the State. Private aid is thus extended by the State in a supervisory capacity and in the furnishing of advice and information on control methods.

Research.—Research in the general interest of forest owners is conducted by each of the three Lake States proper, but little along this line is reported from North Dakota. In Michigan the department of conservation maintains a forest-fire experiment station in cooperation with the Federal Forest Service, and both the State college and university forestry departments carry on investigations for the benefit of woodland owners and the advancement of forestry practice in general.

In Wisconsin the State university cooperates with the Federal Forest Service in the conduct of silvical investigations and in the maintenance of the Forest Products Laboratory.

In Minnesota the forestry department of the university conducts numerous investigations, both independently and in cooperation with the United States Forest Service. It also provides quarters for the Lake States Forest Experiment Station in St. Paul and, in addition, maintains an experimental forest and nursery of its own at Cloquet. The department of conservation formerly spent a considerable amount on research, both independently and in cooperation with the Forest Service, but at present it has discontinued such aid. A rough estimate of expenditures for research in forestry by the Lake States follows:

Michigan:		
Department of conservation	$10,000	
State university	5,000	
State college	12,760	
		$27,760
Wisconsin: College of agriculture		3,000
Minnesota: State university		10,000
North Dakota: Allotted funds to Lake States experiment station		2,500
Total		43,260

Legislation.—Forest tax laws that may be considered a form of State aid to private owners have been passed by the three principal Lake States. The Minnesota law is inoperative, however, owing to county opposition. The Michigan law is being taken advantage of to only a moderate extent, while in Wisconsin, owing to a more liberal interpretation, the forest crop law is more popular. Land listed on January 1, 1932, under these laws as reported by the forest taxation inquiry is as follows:

	Acres
In Michigan	72,701
In Wisconsin	278,275
Total	350,976

In 1932 a special committee in Wisconsin made a report to the Governor on Forest Land Use in Wisconsin, from which the following extracts are quoted:

THE SEVERANCE TAX (FOREST CROP LAW)

> The Wisconsin forest crop law provides that forest-growing land be subject to a limited tax levy of 10 cents per acre, to which the State contributes a like acreage share and exempts the growing timber from current taxation but levies thereon at the time of cutting a severance or yield tax fixed at 10 percent of the "stumpage" value of the products cut and removed. The entry of land under this law is optional with the owner and subject to acceptance by the State at the discretion of the conservation commission. * * *
>
> *Value to State.*—This study indicates a direct financial loss to the State from the operation of the forest crop law, even when it is strictly administered. It is in view of the situation disclosed by this report and the fact that in 1930 over 402,000 acres were entered under the law and that in 1931 applications were made for 430,000 acres of additional entry that the conservation commission revised its more liberal policy as to acceptance of applications for entry. * * * It is for the best interests of all concerned that land on which there is no present forest cover or natural reporduction should not be accepted. * * *
>
> *Value to local taxing district.*—The towns are the direct and principal beneficiary of the forest crop law. They receive in lieu of the property tax that would be levied on the acreage entered 10 cents per acre from the State and 10 cents from the owner. * * *
>
> *Value to private owners.*—The advantage of entry of lands by the private owner under the forest crop law is dependent upon successful forestry practice. Under a misconception of these advantages or merely in the hope of reducing the tax burden many thousands of acres of land have been entered under the forest crop law by private owners without any definite understanding of the management needed to produce a forest crop. While the State's loss on such land is merely a transfer from one public fund to another, with the compensating advantages already referred to, the owner, to justify his enterprise, must develop a timber crop whose ultimate harvesting will return to him more than his accumulated outlay. Therefore the present policy of the conservation commission in con-

> cerning itself as to the return to the State is also a policy of protection to the private owner and may save him from entering into a loss transaction.
>
> Although privately owned lands have been under the forest crop law to any considerable extent for barely three years, and although the conservation department is only now considering the removal of lands on which forestry is not being practiced, many owners are themselves discovering that natural reproduction will not take place rapidly enough or be of a character that will insure a merchantable crop worth the annual tax under the law and in consequence are either removing these lands from its provisions or are abandoning title by failing to pay the acreage share.

Wisconsin has definitely stimulated the creation of county forests. Of all the Lake States, Wisconsin is the only one in which county areas assume an important place in the State forestry scheme. Tax-delinquent land after the period of grace reverts to the counties. From the reverted lands, some 460,000 acres of county forests have been blocked out into forest units.

The Wisconsin forest cooperative law of 1927 was amended in 1929 to permit the counties to list county-owned land on the same terms as that privately owned. For every acre of land listed the State offers to pay 10 cents annually to the township in which the land lies. The county pays nothing. As a further encouragement, the 1931 legislature ordered the conservation department to pay the counties an additional 10 cents to be used in the development of the county forest units. Thus every acre of county forest draws 20 cents of State money each year, 10 cents going to the county and 10 to the township. The State in return is to receive 75 percent of the yield from the county forests. County forests have been established in eight counties and others are in the process of establishment.

In order to understand the alacrity in which the counties are creating forest units, as well as to appraise properly the possibilities of future accomplishments, it is necessary to look into the fiscal system obtaining. In Wisconsin real-estate taxes are collected by the townships, and the portion for county purposes is passed on to the county treasurers. Some of the county funds are then returned to the townships as county aid for schools and other services. A special law permits the townships to turn over the delinquent tax lists to the county in lieu of cash. Thus, from many heavily delinquent townships the county receives no cash or may even be in debt to the township. In one county in 1931, although the county levy was $140,000, after $40,000 was returned to the townships for school districts, there was but $1,500 cash for county purposes. The balance was in the form of delinquent tax lists. The banks have refused further loans, and the county confronts an emergency.

Although county forests exist only in Wisconsin, the counties may become a more important factor in the Minnesota situation. There the title to tax-delinquent land passes to the State after 5 years, but the State holds the land as trustee for the various taxing units in proportion to the unpaid taxes. The State's equity in these taxes is usually less than 10 percent. There is considerable disposition among local county and town officials to maintain that under these circumstances the county, rather than the State, should have the determining voice in regard to what is done with the land. It yet remains to be seen what kind of division of responsibilities will be satisfactorily worked out in Minnesota.

Economic surveys.—Minnesota, Michigan, and Wisconsin have each been engaged lately in economic surveys to determine the character and extent of forest and other lands. Such inventories are very desirable and should prove a valuable basis for planning land-use programs. It is estimated that these States during the fiscal year 1932 spent a total of $41,000 on economic survey work of forest lands, all of which constitutes a form of aid to private owners. The survey work in Minnesota has been temporarily discontinued.

CENTRAL STATES REGION

The central group of States comprises Illinois, Indiana, Iowa, Kansas, Kentucky, Nebraska, Ohio, Tennessee, and West Virginia. Annual State expenditures in aid to private forest owners in the region are given in table 7.

Fire protection.—No fire-protection activities are carried on in Iowa, Nebraska, or Kansas. The remaining six States are all in some form of protection which aids some forest-land owners, and all except Illinois are cooperating with the Federal Government.

TABLE 7.—*Annual State aid to private owners in the Central States, by projects*

Project	Distribution of regional aid	
		Percent
Fire protection	$121,520	54.5
Planting and nursery work	73,628	33.0
Forestry extension	15,883	7.1
Research	12,000	5.4
Total	223,031	100.0

The following summary, by States, shows the proportion of the forest area needing protection which is now being protected from fire:

	Percent
Illinois	20.1
Indiana	16.7
Kentucky	14.7
Ohio	47.3
Tennessee	67.9
West Virginia	67.0

Ohio ranks high in this group in its achievements in well-organized fire protection and other forestry work. In this State all protection funds are provided from public sources. Part of the effort is devoted to the protection of State forested areas. In Indiana, forest-land owners do not, in general, contribute funds for fire protection, but in a few counties and townships owners voluntarily contribute comparatively small amounts for local fire-suppression purposes. Indiana centers protection on the State forests and extends aid to private holdings located in the same region of the State forest areas. In Kentucky a compulsory patrol law is on the statute books, but it is practically inoperative. Virtually all protected areas in the State are those in private ownership. In Tennessee private owners contribute some $3,816 a year, which is a negligible amount, the State furnishing fire-protection aid amounting to more thn $25,000. Most of the Tennessee forest areas protected are privately owned, a minor acreage of State forest areas being included. West Virginia has a compulsory patrol law, but it is not actively enforced. There are two organized fire associations of private owners who contribute approximately $15,000 a year, and assessments amounting to about $4,000 a year are collected and turned into the State forestry department for fire-protection work. Active efforts to enforce the West Virginia compulsory patrol law on a State-wide basis are not deemed advisable. Most private owners now cooperating in the two associations were voluntarily doing so before enactment of the law, and the law itself has not greatly increased the extent of fire-protected areas. The counties aid materially in paying for fire suppression.

Planting.—During the calendar year 1931 all the Central States except Illinois cooperated with the Federal Government in forest planting and nursery work and spent $73,628 of State money. Ohio, the leader in this project, individually spent $36,999 in raising and distributing 3½ million trees, about two thirds of which were planted on private lands and one third on State lands. Tennessee gives private owners State reforestation aid by advice and help in preparing badly eroded land for planting and by furnishing planting stock, chiefly black locust, at nominal cost.

During the period 1926–31 these eight States have distributed over 23 million trees to private forest owners, approximately three fourths going to farmers and one fourth to others. State expenditures for planting activities constitute 33 per cent of the total for all forestry activities in the group.

Extension.—With the exception of Kentucky and Kansas, all the Central States extend aid to private owners in forestry extension through the activities of extension foresters. For the fiscal year 1931 the States themselves spent for this work $15,883 which was 7.1 percent of their expenditure for all State aid in forestry work.

Research.—Indiana is the only State in this group engaged in specific forest research activities. It is estimated that the Department of Conservation spends approximately $4,000 a year of State funds for forest research and investigations. The forestry department of the Purdue Agricultural Experiment Station is also engaged in a study of the effects of grazing on farm wood-lot management, the results of which should prove of aid to private timberland owners. Approximately $8,000 is being spent annually on this reasearch project. In Ohio part of the time of several technical foresters is devoted to research.

SOUTHERN REGION

The southern group comprises Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Texas, and Virginia.

Annual expenditures of State funds to aid private owners in the above States are as follows:

	Amount	Percent
Fire protection	$313, 341	82. 7
Planting and nursery work	25, 339	6. 7
Forestry extension	24, 324	6. 4
Forest research	15, 913	4. 2
	378, 917	100

State aid in this large group of States constitutes but 7.1 percent of of the total amount furnished for aid of private owners in all States. No State forestry organization exists in Arkansas.

Fire protection.—Some owners in all these States, except Arkansas, receive direct aid from the State in the protection of their timberlands from fire, but such aid applies only to those in organized protection areas. The percentage of forest land protected in 1931 in each State was as follows:

	Percent		*Percent*
Alabama	43. 3	North Carolina	39. 1
Florida	8. 1	Oklahoma	10. 7
Louisiana	29. 9	South Carolina	5. 2
Georgia	8. 4	Texas	46. 0
Mississippi	2. 7	Virginia	63. 4

Considering the group as a whole, the State aid extended to private owners in fire protection differs quite materially from that in the Lake, Middle Atlantic, and New England States, where all forest areas are being protected from fire and where practically all protection costs are borne by the public. Protection in the South has not yet been established on a State-wide basis. Furthermore, the Southern States do not make large sums available for protection but rather endeavor to secure voluntary participation of private owners in sharing the costs. For example, prevention and suppression expenditures for the calendar year 1931 were shared between the public and by private owners in the following proportions:

	Percent
States	33
Private owners	23
Federal Government	44
Total	100

The participation and contributions of private owners in fire protection is all voluntary in the South. In Virginia and North Carolina the counties as well as the State provide public aid to owners.

Planting.—All of the Southern States except Texas and Arkansas extend assistance to private owners in planting. This aid through State funds totaled $25,339 during 1931. South Carolina spent $6,003 which was more than was spent by any other State in the group. Annual distribution of planting stock to private owners by all States is approximately 3 million trees, of which about 75 percent are for farm planting and 25 percent for planting on other private holdings. Several large paper and lumber companies are engaged in planting projects on their holdings and operate well-managed forest nurseries. Advice furnished by State and Federal forestry representatives has been of material aid in this work.

Extension.—Eight States employ extension foresters and furnish private owners, especially owners of farm woodland, with planting and management demonstrations and advice. Oklahoma, Florida, and South Carolina do not employ extension foresters. Florida, however, performs important extension work in cooperation with the Bureau of Chemistry and Soils by having a technical employee devote part time in promoting and demonstrating improved turpentining practices. State annual expenditures amount to about $24,324 in these States for extension activities, which constitutes 26.2 percent of the total for all State aid forestry work.

Research.—During the fiscal year 1932 approximately $15,913 was spent in Arkansas, Georgia, and Texas for activities in forest research of indirect aid to private owners. Expenditures were approximately as follows:

Arkansas	$4, 000
Georgia	11, 163
Texas	750
Total	15, 913

In Arkansas a forester is employed by the State University primarily for forest investigations. Georgia is committed to a cooperative research program to ascertain the possibilities of producing newsprint and white paper stock from southern pines. A special State appropriation of $40,000 is made available for 1932 and 1933 through the Department of Geology and Forestry in cooperation with the Chemical Foundation, Inc., of New York City. Of this sum $11,163 was spent in the fiscal year ending June 30, 1932. The Foundation has set aside $50,000 for this cooperative research project contingent upon State appropriations. In Texas a limited amount of research is performed on the three State forests, but no personnel is engaged for research alone. In several Southern States, State forestry employees contribute services on research projects conducted by the Federal Forest Experiment Station.

PACIFIC COAST REGION

The States in this group comprise California, Oregon, and Washington. Annual expenditures for State aid to private owners are as follows:

	Amount	Percent
Fire protection	$298, 097	73. 9
Planting and nursery work	17, 372	4. 3
Forestry extension	3, 271	. 8
Tree disease control	35, 750	8. 9
Insect control	7, 734	1. 9
Research	31, 500	7. 8
Forest survey	9, 500	2. 4
Total	403, 224	100

Fire protection.—State aid in the form of appropriations for fire protection in this region constitues 9.3 percent of the total expenditure for such aid in all States. Compulsory patrol laws require private owners to provide fire protection for their forest properties. State funds spent for fire prevention, suppression, fire-law enforcement, etc., all aid private owners. Private forest owners are aided to a greater extent when public funds bear a major rather than a minor portion of the total expenditures. In the Pacific Coast States private owners share very materially in providing funds for fire protection and therefore receive a relatively lesser amount of direct financial aid than in those Lake and Eastern States where practically the entire costs of fire protection are borne by the States and Federal Government.

Planting.—These States have not been active in planting and nursery work. The Pacific coast region has been the last one of our great forest regions to be exploited, and protection of mature stands has been the principal need rather than the reforestation of denuded areas. However, all three States are at present cooperating under section 4 of the Clarke-McNary law in the establishment of nurseries and distribution of planting stock to farmers. During the calendar year 1931 they put $17,372 of State money into such work, but the distribution was only 267,000 trees. Oregon led with a distribution of 198,500 seedlings and transplants.

Extension.—California is the only one of this group of States employing an extension forester under cooperative provisions of the Clarke-McNary law. During the fiscal year 1931 it engaged in forest extension work to the amount of $3,271.

Blister-rust control.—During the fiscal year 1932 all three States provided funds for coopertive white pine blister rust control work, spending a total of $35,750, which was of benefit to private owners.

Insect control.—In 1931 the State of Washington, one county, and certain private forest interests combined to finance a $15,000 project for the control of a hemlock looper infestation. An airplane was used to dust 5,000 acres, and the Bureau of Entomology considered the control project successful. The use of the airplane was unique as a method of forest insect control. Of the total cost of the enterprise the State contributed $6,810, the county $924, and the private owners $7,266.

While these States do not, in general, make direct funds available for forest insect control, several have provided for means of control by legislative enactments. When forest insect outbreaks occur, the States are authorized to declare zones of infestation, and the owners are required to provide control measures or funds. Pine beetle control projects under the provisions of the Oregon law have been under way for several years.

Research.—State funds amounting to $31,500 were made available during the fiscal year 1932 for research work, a total exceeded only in the Middle Atlantic and Lake regions. California is outstanding in the Pacific group in the amount of State aid extended for forest research. As reflecting both public and private interest in forest research problems, the State annually allots to the division of forestry of the State university about $15,000 for forest research, and the State and various counties cooperate with the Federal Forest Experiment Station by contributing annually approximately $15,500. A cooperative project in research on fire-fighting equipment was recently financed by several of the Northwestern States. Washington and Oregon each contributed $500 last year on this study.

Legislation.—Reforestation legislation which offers aid in the stabilization of taxes on cut-over lands and second-growth timber is provided in both Oregon and Washington. While such State aid cannot be evaluated in monetary figures, its operation is of distinct advantage to private owners of young timber.

NORTH ROCKY MOUNTAIN REGION

Only the States of Idaho and Montana are included in this group and both are extending State aid to private owners. Annual expenditures for such aid are given in table 8.

Fire protection.—State funds that are made available for fire protection are used for the protection of State-owned rather than private lands. Such State expenditures are therefore not included in this report. Many private owners in these States provide funds for the protection of their forest properties in cooperation with the Federal Government under the Clarke-McNary law, the States themselves not sharing in this phase of the work.

TABLE 8.—*Annual State aid to private owners in North Rocky Mountain region, by projects*

Project	Distribution of regional aid	
	Amount	Percent
Planting and nursery work	$6,349	29.7
Forestry extension	2,004	9.4
Forest research	13,000	60.9
Total	21,353	100.0

Planting.—Both States cooperate with the Federal Government in planting, and during the calendar year 1931 they spent $6,349 of State money under this head as an aid to farmers. Montana is doing the larger share. In 1931 the two States distributed a total of 467,600 trees, of which all but 32,500 went to farmers. Planting projects and nursery production have been increasing there during recent years.

Research.—The State of Idaho regularly allots State funds to the University of Idaho Forest School for forest research. The amount of $12,000 represents the portion falling within the scope of this report. Research in forest products, pathology, and slash disposal has been conducted which is for the benefit of private owners. Montana forest research activities are estimated at $1,000 annually. The studies there are conducted by technical forestry employees of the State.

Legislation.—Idaho owns some 452,000 acres of State forest, and sales of timber, grazing leases, cottage and camp sites, etc., brought in $135,499 last year. State forest sales funds are held in a trust fund for educational work within the State. Idaho has a reforestation law similar in principle to those of Oregon and Washington which may be considered a form of State aid to private owners. In Idaho the application of the reforestation law is left to the option of the private owner and only a relatively small amount of interest has thus far been manifested in the listing of lands. Only 53,371 acres of private land has been listed.

SOUTH ROCKY MOUNTAIN REGION

The South Rocky Mountain Region includes the States of Arizona, Colorado, Nevada, New Mexico, South Dakota, Utah, and Wyoming. All except Arizona and South Dakota provide some form of State aid in forestry to private owners. Annual expenditures for such aid are given in table 9.

Fire protection.—State aid in fire protection is extended only in New Mexico and Nevada. State funds for fire protection are made available in South Dakota but are used primarily for the protection of the Custer State Park. In Utah and Arizona the acreage of privately owned lands is small, and, since such areas largely lie adjacent to or within the national forests, protection from fire is provided by the Federal Government.

During the fiscal year 1932 New Mexico spent $2,762 of State money for fire protection, and private owners contributed $3,633. In Nevada, State aid in protection is practically negligible, amounting to but $105 in 1932, while private owners spent $5,695.

Planting.—The States of Colorado, Utah, and Whoming are cooperating with the Federal Government in planting projects. During the calendar year 1931 they put a total of $5,467 into the work. A total of approximately 258,583 trees were distributed, most of which went for farm planting. Colorado led, with 126,000 trees distributed. Colorado has a law exempting forest plantations from taxes during the first 10 years, but it has not proved a sufficiently valuable inducement to advance private planting appreciably. South Dakota has a similar law providing tax exemption for the first 5 years, but it also has proved ineffective.

Extension.—Utah and Wyoming cooperate in extension work. State funds thus spent amounted to $2,800 during the fiscal year 1931. Farmers also receive aid and information in planting from the horticultural department of the University of Wyoming.

TABLE 9.—*Annual State aid to private owners in South Rocky Mountain region, by projects*

Project	Distribution of regional aid	
	Amount	Percent
Fire protection	$2,867	25.8
Planting and nursery work	5,467	49.1
Forestry extension	2,800	25.1
Total	11,134	100.0

CONCLUSION

In reviewing the aid which the States are now extending to private forest owners, it is pertinent to mention the effect which Federal aid has exercised on State aid in forestry. Local forestry leadership and legislative action is principally responsible for present local and State interest and participation. However, those most closely in touch with State and private forestry work frankly acknowledge the fact that every State cooperative forestry function has been either created or vitally strengthened by Federal aid extended under the Clarke-McNary law. It is recognized that in many States full realization of State and local responsibility for aiding in the improvement of forest practice is far from ultimate attainment. Even in those States, however, progress would have been still less advanced had Federal help not been extended. Distinct gains are to be noted under the existing plan of Federal cooperative aid, which should continue to stimulate increased State and private aid to and interest in forestry. State aid to private owners, which now accounts for annual expenditures in the neighborhood of $5,330,000, was supplemented in the fiscal year 1932 by Federal funds amounting to $1,762,966 for the specific projects of fire protection, planting, and forestry extension under the terms of the Clarke-McNary Act.

Great differences both in emphasis on the various projects and in the extent of State financial participation may be pointed out in widely distant States and regions. When viewed by regions, however, a general similarity of forestry activities and likewise of interest is found. Although different States usually extend State aid for forestry according to the problems needing most urgent attention, the problem of fire control is quite generally recognized as of the first importance and as fundamentally necessary to the success of most others. The establishment of this point of view is in itself an achievement of the highest significance for the future of forestry. Fire is the most destructive agent to which our forests are subjected, and the general determination to control it finds expression in the large proportionate sums provided for fire protection by State, private, and Federal agencies.

Considering emergency activities in the form of State aid, it is pertinent to note that the States in their efforts to safeguard private timber resources have provided funds in excess of a million dollars annually for the control of destructive forest insects and diseases.

At present no standard policy exists among the States as to the extent to which they should participate in extending direct and indirect aid to private forest owners.

Most States in the New England, Middle Atlantic, and Lake regions are now extending aid to private owners to a greater extent than is found in any other region. Here private aid in fire protection is extended almost entirely by the public. In the West the common understanding is prevalent that it is proper for private forest owners to carry a material part of the load of fire protection, and legislation has been enacted to bring this about. In the South, State aid is being extended with the principal objective of building up private participation of voluntary nature.

Figure 3 shows the amount of all forms of State aid in forestry being extended annually to private owners and it likewise shows the amounts which the private owners are expending for fire protection. The graph also shows the areas of privately owned commercial forest lands. The acreage of forest lands in itself should not be interpreted as representing or constituting anything more than a rough correlation between what the States are doing to aid private owners in forestry and what they should do. For example, fire protection on a comparative acreage basis costs five times as much in some regions as in others. Likewise States where destructive forest-insect epidemics or tree-disease infestations are prevalent must include in their forestry budgets control expenditure items which would not need be part of the forestry costs in States where such epidemics or infestations were absent. However, since cost figures are not available for the amount which each State should provide for aid to private owners the acreage of privately owned lands rather than cost estimates have been used as one means of giving the reader at least some idea of the extent of the forestry job on privately owned forest lands.

The fundamental principles of extending aid to private owners by the States is apparently now well established. The extent to which present aid will be supplemented in the immediate future by needed additional support is problematical. It seems reasonably certain, however, that State interest and aid as now extended to private owners will be continued and will be expanded as Federal and local interests in forestry develop and as the States themselves become better able financially to meet their broader responsibilities in this field.

FACTORS AFFECTING FEDERAL AND STATE AID

CONTENTS

Page
Federal aid 1203
The Federal interest in State forestry 1205
Erosion and flood control 1206
Factors affecting policy of Federal aid 1208
Financing the Federal aid system 1219
State aid 1223
State forestry legislation and appropriations 1224
State interest in forestry 1225
Factors affecting State action 1225
Conclusions 1227

FEDERAL AID

By Fred Morrell, Assistant Forester, in Charge Branch of Public Relations

The traditional policy of the United States as to disposition of forest land is one of private ownership. Through liberal and laxly enforced laws for private acquisition and through grants to States, railroads, and other public and semipublic institutions, the largest share of the forest lands of the country had passed from Federal ownership before the policy of disposition was in part reversed by the act of March 3, 1891, which authorized the President to withdraw from entry remaining federally owned lands suitable for forestry purposes.

The States had generally followed the Federal policy of disposing of grant lands to private owners, and large grantors, of whom railroad companies were the most important, followed a similar plan. Therefore, when early in the present century public concern was aroused over the possibilities of a shortage of timber supplies and the condition of watersheds, the question was largely related to land in private ownership.

Following the act of 1891 approximately 20 percent of the remaining forest land of the country had been withdrawn from entry and included in the national forest system. Practically all of this was in the far western public-domain States. The States still owned a large acreage of forest land, but this was in general being passed to private ownership as fast as possible under generous disposal policies. A few States had made small beginnings toward permanent ownership and management of forest lands, and a relatively small aggregate area was held by municipalities and minor political subdivisions for the protection of public water supply. Many owners were actively engaged in protecting and otherwise managing their forest lands with the purpose of preserving existing timber values until they could be liquidated through cutting, in creating new values, or in preserving forest conditions for other reasons. This was being done both by individuals and by owner associations, the efforts of the latter being predominant in the Northwest, where owners were carrying heavy investments in commercial timber that were particularly liable to fire losses.

In 1911, the public concern in the state of forested lands culminated in the enactment of the Weeks law for Federal aid in forestry. At that time 16 States had provided by law for systems of protection extending over part or all of the forest land within their borders and had set up organizations for actual protection work. Protection of privately owned forests as a function of government had thus been firmly established.

Since Federal ownership represented the most certain form of progress, continued protection and improvement of Federal properties, as well as extension of Federal ownership, was obviously desirable policy from a forestry standpoint. But it was clearly impracticable to extend Federal ownership at once to any large percentage of forest land in which the public was interested. Such a course was barred both by the enormous sums of money that would be required for acquisition and management, and by the thoroughly established system of private ownership. A second possibility was to leave the land in private and other ownership but to bring about through regulation such systems of management as would safeguard the public interest. Most leaders in the movement believed that public dictation in the management of privately owned forest land would be contrary to traditional American thought and custom, and hence at that time impracticable, even where considered desirable.

It was apparent that the existing classes of forest-land ownership would continue, and that therefore any complete Federal program would have to extend to all of them. It seemed also apparent that the easiest and least expensive way, if not the only possible way, for the Federal Government to exert any wide influence immediately was through working with the facilities already set up. Through the medium of Federal assistance conditioned on State assistance of at least equal amount it was hoped that owners of forest land would be encouraged to hold it for forestry purposes. It was believed that the majority would find it to their interest to install such practices as would satisfy the public need and that eventually public requirements agreeable to most landowners would follow to insure the results desired. The legislation embodied in the Weeks Act (March 1, 1911) followed out these general ideas in creating what is known as the Federal-aid system.

While the Weeks Act provided for Federal acquisition of forest land and Federal aid in protecting State and privately owned land from fire, it expressly applied only to forest land on the watersheds of navigable streams. There is much evidence, however, that navigability of streams was not in reality the prime incentive for the legislation. A review of the statements made by those interested in promoting Federal acquisition, fire protection, and forestry extension indicates that they had in view all of the public values inherent in forestry. Aid to navigation was but one of the considerations, although in the minds of some of those who supported the legislation it may have constituted a sufficient single reason for the action taken.

The gains established through the administration of the Weeks Act have been consolidated and enlarged through the Clarke-McNary Act of June 7, 1924, the operation of which has already been discussed in some detail. Briefly, the principle of Federal aid to the States is now well intrenched, the States have responded with large contributions to forestry on their own account, and the situation promises well for the Nation-wide forestry program of the future.

THE FEDERAL INTEREST IN STATE FORESTRY

The most important reasons which foresters and other prominent advocates have assigned for Federal participation in forestry activities are the following:

1. The provision of an adequate timber supply.
2. Erosion and flood control.
3. Safeguarding scenic and recreational interest.

To what degree these objectives are of concern to the Federal Government is a question deserving a brief analysis at this point.

THE INTERSTATE INTEREST IN TIMBER SUPPLY

In table 1 are shown, by regions, estimates of the present annual cut of timber, present annual amount of wood used, and the ultimate annual growth of wood that may reasonably be expected under such handling of the forest lands as would presumably result if the objectives set up in this report were attained. (See section "Present and Potential Timber Resources." Subsection on "Timber Growth.") These estimates afford some idea of what the situation may be when all or most of our remaining virgin timber has been harvested and the country is faced with the necessity of balancing its consumption against production.

Here the interdependence of the various regions of the country is plainly indicated by the figures of present consumption and present cut. While the totals roughly balance, in no region are forest demand and forest supply even approximately equal.

Furthermore, even though a State may produce a total much larger than it consumes, no one State produces all the forest products that it needs and uses. In every State there is need for woods of a kind or quality which it does not produce, and which are more cheaply or conveniently obtained from other States. The Pacific Coast States, for example, contain only small quantities of hardwoods and must secure their main supply from the South and East. Table 2 proves the reality and magnitude of this interstate dependence. It shows that in the distribution of all sawed lumber used in 1928 more than half of it crossed State lines. The problem of timber supply is thus obviously a matter of concern not only to individual States but to the Nation as a whole.

TABLE 1.—*Present annual timber cut, consumption, and theoretical ultimate future growth of timber in the United States*

Region	Present cut	Present consumption	Theoretical ultimate growth
	Million cubic feet	*Million cubic feet*	*Million cubic feet*
New England	619	874	748
Middle Atlantic	772	2, 567	1, 002
Lake States	1, 267	1, 770	1, 773
Central	2, 067	4, 113	1, 959
South	6, 418	3, 970	9, 500
Pacific Coast	2, 937	1, 408	2, 059
North Rocky Mountain	287	114	499
South Rocky Mountain	128	248	215
Total	14, 495	15, 064	17, 755

TABLE 2.—*Sawed lumber derived from other States, 1928* [1]

	1,000 feet board measure
Alabama	174, 498
Arizona	42, 333
Arkansas	110, 939
California	2, 055, 048
Colorado	185, 476
Connecticut	232, 767
Delaware	41, 955
Florida	22, 911
Georgia	119, 344
Idaho	67, 203
Illinois	2, 236, 314
Indiana	753, 617
Iowa	540, 395
Kansas	404, 201
Kentucky	393, 410
Louisiana	229, 783
Maine	54, 962
Maryland and District of Columbia	503, 389
Massachusetts	627, 141
Michigan	1, 162, 033
Minnesota	533, 844
Mississippi	44, 097
Missouri	678, 959
Montana	74, 164
Nebraska	303, 770
Nevada	53, 539
New Hampshire	67, 535
New Jersey	665, 869
New Mexico	47, 125
New York	2, 486, 134
North Carolina	206, 229
North Dakota	136, 711
Ohio	1, 383, 251
Oklahoma	346, 644
Oregon	86, 151
Pennsylvania	1, 534, 379
Rhode Island	151, 626
South Carolina	25, 104
South Dakota	137, 840
Tennessee	563, 116
Texas	723, 643
Utah	120, 443
Vermont	25, 487
Virginia	293, 154
West Virginia	117, 422
Washington and Alaska	153, 832
Wisconsin	561, 165
Wyoming	110, 586
Total	21, 589, 538

EROSION AND FLOOD CONTROL

No quantitative estimates can be cited to indicate the interstate interest in forests from the standpoint of their value in reducing the destructive forces of water, but the hundreds of millions of dollars spent by the Federal Government on levee construction alone affords some measure of the Nation's concern in flood control as such. Investigations tend to prove that forestry is a basic instrumentality of flood control hitherto neglected. As to soil erosion, it is known to have a disastrous effect through impoverishment of the area from which it comes and sometimes even more through sanding and silting of the region in which it is deposited. If, therefore, through depletion of forest cover erosion is accelerated, damage arises to the public to the extent that it is interested either in soil productivity or in the navigability or purity of streams.

---

[1] Forest Service estimates.

The interstate interest in forested watersheds from these various points of view is fully discussed in another section of this report. For the purpose of illustration here it will be sufficient to call attention to the vast territorial range of only three of our major drainage systems. The Mississippi system drains all or parts of 31 States, and its watersheds include about one fourth of the total forest land of the country. The watersheds of the Columbia and the Colorado each include nearly one tenth of the total forest land. The Columbia drains parts of 6 States, and the Colorado parts of 6 States. Control of floods, erosion, or any other problem of such river systems is a matter of Federal no less than State and local concern. And it is a fundamental premise of forestry that every successful effort made by the public toward restoring, maintaining, and protecting forest and vegetative cover is directly reflected in better control of floods, erosion, and run-off in general.

SCENIC AND RECREATIONAL INTERESTS

The interstate use of forest land for scenic and recreational purposes depends on a proper combination of natural features to appeal to the outdoor interests of the American public. As a rule, the most popular vacation areas are to be found in mountainous or lake country with a cool summer climate.

It is not believed that interstate as against State use of forest land for recreation should be given too serious weight in determining a Federal aid policy, particularly if the Federal aid is largely compensating through similarity of State situations. The relative value of resources to the State as compared to their value to the Nation as a whole is particularly difficult to estimate, and the interests of both parties should be given fair consideration. Some light is thrown on this aspect of the case by a United States Bureau of Biological Survey report showing that of some 7 million State hunting licenses issued for the 1929–30 season, only about 55,000 were to nonresidents. A prominent example of nonresident recreation is seen in Colorado, where, according to estimates of the "Colorado Association," 790,000 summer visitors in 1931 spent $72,396,000, paying to the State $436,142, in gasoline tax alone. A similar report from the "New England Council" estimates that over $500,000,000 is spent in that region annually by recreationists, many of whom, of course, cross State boundaries on the way.

On the other hand, while each national park is visited by people from every State each year, Park Service reports indicate a relatively much greater use by people residing near them. For example, about 20 percent of the annual visitors to Yellowstone Park are residents of the three States surrounding it, although the combined population of these States is only 1 percent of the total population of the United States. Of the visitors to Rocky Mountain National Park more than 50 percent are Colorado residents, and at Yosemite more than 90 percent have registered as Californians.

The pecuniary advantages of the tourist business to States and communities in which Federally supported properties are located are, of course, generally recognized, and accepted, where the resources are of sufficient national interest to warrant the Federal expense involved. But the principle upon which Federal care of areas of outstanding educational, scenic, and recreational value is justified has very much less application in determining a Federal-aid policy for protection of vast acreages of privately and State owned forest lands.

No attempt is made here to evaluate this factor as against cost of maintaining the conditions that make forest lands attractive for that purpose. The intent is only to point out that it is a factor that should be weighed in determining a Federal-aid policy.

FACTORS AFFECTING POLICY OF FEDERAL AID

Some of the broader national considerations pointing to Federal participation in State forestry affairs, together with the degree of the Federal interest, have now been explained. The system of Federal aid in forestry as it operates under present-day legislation and appropriations has been described in a preceding section. It remains to consider as realistically as possible the more specific factors which condition the usefulness of Federal aid and which must be observed in the successful administration of its present and future programs.

Against the Federal-aid forestry projects it has sometimes been argued that a Federal bureau has been put in a position where it can dictate State policies and procedure by threat of withdrawing funds, thus weakening State and private initiative and independence; that States in which the ratio of Federal taxes to allotments is high are made to pay for forestry in States where the reverse is the case; and that the bait of Federal funds has caused some States to appropriate more for the work than they should.

In other words, the issue of Federal aid in forestry is on all fours with the issue in many other forms of Federal aid. It must be admitted that there are arguments on both sides, and Federal aid must depend for justification on whether or not its advantages outweigh its disadvantages. The position taken by the writer is that the advantages predominate, provided that the law is administered in a cooperative and not a dictatorial way, that a proper balance is maintained between Federal contribution and Federal requirements, and that Federal assistance to States and private owners is maintained on a ratio that properly represents the national as compared with State and private interest. These considerations are factors in all of the activities of Federal aid in forestry as now administered. The more important activities demand separate discussion and will be taken up in the following order: Protection against fire, establishment of woodlands, woodland management, research, control of forest insects, control of tree diseases, acquisition of lands, and finance.

PROTECTION AGAINST FIRE

ATTITUDE OF LANDOWNERS

The major interest of owners of forest land in the past has been in the merchantable wood that it supported rather than in the growing of another crop of timber. Following the clearing of many millions of acres of land and its devotion to farming, it came to be the general belief that most forest land would, after the timber was removed, be absorbed in agriculture. While there was altogether a large acreage of timber on soil that was too rocky or too steep to be cultivated, even that land was thought to have pasturage possibilities. As a rule no effort whatever was made to preserve conditions that would result in another crop of timber.

Today, as a result of a long period of adversity for agriculture, the view is quite different. Owners of forest land have now very widely accepted the opinion that such land holds small promise of being valuable for economic purposes other than timber growing. Great progress has therefore been made toward a general understanding that fires are a detriment to future values rather than a help in preparing the land for a better use. That realization has not, however, resulted in a universally active interest in fire protection on the part of landowners. A large percentage of cut-over land now supports no timber of merchantable size and quality, and contains little young growth of any considerable size. The possibility of cutting another timber crop from it is too far removed to be of definite interest to the average landowner, and the sale value of young-growth forests, except in the Northeastern States and the naval-stores region in the South, has been as a rule very small. Hence owners have been deprived of any financial incentive for protecting such lands.

On the other hand, where forests constitute present marketable values that are in danger of destruction from fire, the interest of the owners has been keen, and large sums of money have been expended by them for protection. But the owner's expenditure will necessarily be in proportion to what he regards as his risk of loss, and it cannot be expected that private activity in protecting cut-over forest land will be great unless increase in values through growth promises more than enough to offset protection and carrying charges. Owners have no difficulty in understanding this proposition. It is believed, however, that timber values are in sight on many cut-over lands, much nearer than the owners now appreciate. A great opportunity for Federal aid lies in building up better morale among landowners with respect to fire protection. The means provided are definitely suited to the purpose, though not yet adequate, namely, sharing the burden of costs and pointing out prospective values on the land. At present the success of Federal aid is severely handicapped by the pessimism of many owners.

PUBLIC ATTITUDE TOWARD FOREST FIRE PROTECTION

The former indifferent attitude of the resident nonlandowning public toward forest fires has changed greatly during the last 20 years as a result of anti-fire propaganda and the growing opposition of owners to forest burning as such. Except in some regions in the South, forest fires are very generally regarded as an evil and their prevention and suppression as an obligation. There is still not a sufficiently aroused public feeling, however, or a sufficient feeling of personal responsibility to make adequate protection possible at reasonable cost in many parts of the country.

Again, in the regions of larger timberland holdings there may be found an unsympathetic attitude toward fire protection because of a rather widespread antagonism to the corporations or individuals holding the land. While it may arise from a number of causes, it reflects a common feeling of protest against the larger holdings. Too often the local residents consider that fire is not damaging them but is putting an opposed group to loss or inconvenience. Therefore, while they would not maliciously set fires or hinder the efforts of the landowners to control them, they are not greatly concerned unless fires assume disastrous proportions. The need here is to intensify the conviction that forests are a community asset, regardless of who owns them, and that "everybody loses when fires burn." The difficulty of enforcing fire laws where this conviction does not exist is obvious.

Federal and State participation in the actual expense and organization for fire control has been a large factor in improving the point of view of the resident public. The fact that public agencies are in partnership with the landowner in fire protection or have taken over the whole task as a matter of public responsibility is a convincing argument in favor of care and active cooperation on the part of the individual citizen, altogether apart from the fear of legal penalties for acts of incendiarism.

USE OF FIRE ON LAND BELONGING TO OTHERS

Official estimates indicate that more than one third of the fires occurring on forest lands under protection are caused by smokers and campers, mostly on land belonging to other people. Through tradition and custom, the right of the public to make use of the forests and woodlands in private ownership for hunting, fishing, and other forms of recreation is well established. While there are laws in many States protecting landowners against undue use of this sort, they are generally deficient if reviewed from the standpoint of fire protection alone, and are especially difficult of enforcement. The solution of the problem involves questions such as seasons open to hunting and fishing, and will ultimately require a balancing of benefits and hazards and an equitable adjustment between public rights and requirements and those of the landowner. The matter can now be handled only by the State, even the use of federally owned forest land being, under the terms of withdrawal, largely subject to State statutes in these respects.

NECESSARY USE OF FIRE BY LANDOWNER

Fire is an essential tool in logging, land clearing, farming, and construction projects. It follows that its use by the landowner or tenant must be legalized under the general rights of ownership, provided that such use does not infringe on the rights of other individuals or the general public.

Fires spread easily, and the establishment of practices necessary in the public interest and not unduly burdensome on the landowner offers many difficulties. It involves the establishment by law of seasons during which burning for disposal of debris or for other purposes is permissible, and of the conditions under which it may be done. In regions of serious fire hazard, proper protection requires the setting up of local authority for the issuance of burning permits and provision for inspection work and law enforcement.

Few single causes have been responsible for more disastrous forest fires than inflammable material left on the ground after cutting and removal of timber. As a general rule approximately 40 percent of the tree has been left behind as of no commercial value. In addition there is often a large amount of dead-and-down material. Owners of forest land have not been generally willing, of their own accord, to dispose of this material by methods that insure against spread of fire, because they have not regarded the loss that they themselves might suffer as equal to the cost of proper disposal. Most States have passed laws requiring one form or another of so-called slash disposal. Some of the laws need strengthening and clarification, but, generally speaking, the difficulty lies more in enforcement than in lack of legal authority. Proper slash burning requires careful piling, the right day for burning, and care and judgment in the operation.

Very commonly the precautionary measures necessary to prevent the spread of fire from slash or other burnings represent some hardship and expense to the landowner, and many problems are involved in arriving at and enforcing requirements fair to all concerned. Ability of a protective organization to solve these difficulties and those discussed in the caption above depends very largely on the attitude of the public toward fires. If local sentiment is antagonistic or indifferent, it can be accomplished only in part and at relatively large expense.

STATE LEGAL BASIS

The Federal statute requires the State to provide by law for a system of fire protection before it can participate in Federal appropriations for that purpose. All of the States with forest lands in need of organized protection have made legal provisions which the Federal Government has regarded as meeting requirements for at least a beginning of cooperative protection, although in three States cooperation is not now active. There has been a very gratifying disposition throughout the States to amend their fire protection laws or to enact new laws based on the experience of other States when it has seemed that gains could be made by such a policy. Federal aid has been influential in bringing such changes about through the advice of experienced Federal cooperative agents and through pressure for legislation considered adequate and appropriate as a condition of continuing the Federal assistance. Nevertheless, an ideal basis of State cooperation is far from attainment in many cases.

Systems of protection necessarily vary greatly according to forest conditions and fiscal limitations in the different States, but there are five principles that should be followed as a standard.

1. Forest-fire protection, along with other forestry activities in the State, should be placed by law under the supervision of a nonpolitical, technically competent, and reasonably permanent department, board, commission, or other authority, serving in forestry matters alone or in connection with other conservation activities, and hereinafter referred to as "the commission."

2. The law should provide for placing responsibility for protection directly on an official with adequate experience and training, to be selected by the commission. It should delegate to this official wide latitude in administration, subject to review by the commission only in the more important phases of policy, planning, and accomplishment.

3. Provision should be made for operation of the merit system in matters of employment and promotion, and responsibility for proper discipline and control should be lodged with the State officer above designated, subject to appeal to the commission.

4. Salary ranges and other conditions of employment should be set by the commission.

5. In States where private owners are expected to pay a share of protection costs, the law should make specific provision for and outline broadly, subject to regulation by the commission, the terms under which private cooperation is to be recognized.

An analysis of existing State laws shows many failures to fulfill these various requirements. Likewise performance in fire protection shows weakness directly traceable to that failure. Continuing allotments of Federal funds to States should be more and more firmly conditioned on the adequacy and effectiveness of State laws and the competency of organization under them.

ESTABLISHMENT OF FARM WOODLANDS

Provision for Federal aid in farm tree plantings was made in the Clarke-McNary Act at the instance of those who believed that a national program of forestry should include the establishment of woodlands and shelter belts on farms, both for wood production and for the sake of other economic and social returns through shelter to livestock, shade, and farm beautification.

The farmer who owns submarginal farm acres that might better be used for growing trees is generally in a better position to plant trees than the owner of large areas of forest land, because he may be able to do it in off seasons without extra expenditures for labor. For the same reason, and because he can utilize his product more closely, he is able to realize greater net returns for what he grows. However, the total of resulting wood products that would find their way into the market, or the savings in timber on other forest areas, is as yet of much less consequence than the benefits from shade and shelter and from growing on the farms a limited quantity of needed material which otherwise would not be available for farmers' use. Whether farm forest plantations will become a major factor in the Nation's timber supply remains a question for the future to answer.

Federal aid in the planting of farm woodlands amounts to a small subsidy to State nurseries. Produced in large quantities under competent management, trees suitable for farm planting can be raised at prices greatly below those at which commercial nurserymen sell them. State nurseries for growing such stock can be made largely self-supporting through sales. Free distribution of stock has not generally been found as satisfactory as sale at prices approximating costs of production, because when trees are free many people will ask for them who have no plans or well-formed intention of properly planting and protecting them.

One of the arguments that has been offered against this project is that it furnishes a form of Federal aid to a single class of citizens, and that there is no more reason why farmers should be provided trees free or at low cost for planting than other landowners. Much more determined and forceful objections have come from some commercial nurserymen, who have contended that through Federal encouragement and participation the States have engaged in the growing of nursery stock in competition with private business, and that since the State nurseries are in part supported by public funds private nurserymen are unable to compete.

The validity of both these arguments must be recognized, and justification for the projects rests on the question whether public interest is best served through the encouragement to tree planting that the Federal act provides or through encouragement to business by withdrawing from this field in favor of the commercial nurserymen.

In the first place, it is believed that no distinction between farmers and others should be made in the distribution of nursery stock, for reasons that will be discussed later. On the question of State competition it is the belief of State and Federal workers acquainted with the project that it has on the whole stimulated rather than restricted the business of commercial nurserymen. The general observation of public officials has been that farmers cannot or will not pay the seedling prices charged by commercial nurserymen for farm planting on an extensive scale, and that unless they can secure stock at much lower cost it will not be planted. But an actual or potential increase in commercial nursery business is seen in the fact that State nurseries do not generally supply trees for ornamental planting (the Federal Government in no case participates in that), and that the establishment of forest plantations and shelter belts tends to stimulate this demand.

Commercial nurserymen have also contended that when planting stock is supplied to farmers at very low prices, the result is much the same as if it were free. Nurserymen argue that if it costs nothing to secure the stock the farmer will often order it without any well-considered plans for planting, and consequently seedling distribution does not result in the woodlands and shelter belts contemplated by the law and its sponsors. The validity of this argument is recognized. It is not believed that public aid should extend beyond furnishing farmers or others needed technical advice and nursery stock at a price that will insure their interest if they order and pay for the trees. There is nothing to prevent the States purchasing the stock from private nurserymen if they are in position to furnish it at favorable prices.

Assuming limited basis of Federal cooperation, there would seem to be no good reason why the privilege of purchasing State-grown trees should not be extended to all landowners who wish to engage in the project of planting forests. The Forest Service has several times reported favorably on proposed amendments of the Clarke-McNary Act, which, if enacted, would extend its scope as thus indicated.

Federal interests in forest planting would seem to be as well served through planting by other landowners as by farmers, and many difficulties of administration would be avoided by the proposed change. It is not believed that large increases in Federal funds are called for in any event.

FEDERAL AID IN WOODLAND MANAGEMENT

FARM WOODLANDS

Approximately 20 percent of all the forest land of the country is in native woodlands on farms. They represent by far the most stable form of private ownership, and, from this important angle at least, they offer the best field for improvement of private forestry practice and increase of production and hence are an entirely fitting field for Federal aid. In many communities and in a number of the most extensively forested States, farm woodlands are the major source of raw materials for the wood-manufacturing industries. They supply, in addition, a very large quantity of the fuel and structural material that is used on the farms. They are thus a considerable factor in the national timber supply, and their maintenance and improvement have important interstate aspects.

Farm woodlands may hold part of the answer to the national problem of agricultural distress. They offer possibilities in the use of labor on farms during inactive seasons, which commonly makes it possible for farm owners to hold forest land and sell from it manufactured or partially manufactured products, the receipts for which are net, as against sales of products by owners of more extensive forest areas, which entail a heavy expense for labor.

Total annual public expenditures, Federal and State, for cooperation in farm woodland management approximate $160,000 a year. This is essentially an extension activity and is administered as such. The funds provide for the employment of less than one field specialist for each 3 million acres of farm woodland, or perhaps about one to each 50,000 owners. Under the plan of organization, the field specialists, generally one in each State, work with the assistance of the county agents, who are expected to carry on forestry as a part of the general farm extension work. A large percentage of the poorer agricultural counties, in which the acreage of farm woodlands is high, do not employ county agents and so receive no assistance except what may be extended by the State extension forester direct. In other counties, owing to the pressure of other work, lack of training, or lack of interest, the county agents frequently furnish little advice regarding farm woodland management. While the results obtained thus far are apparently commensurate with public expenditures for the purpose, possibilities for greater returns through increased public activity are relatively large.

WOODLANDS NOT ON FARMS

From the abstract standpoint of Federal interest in the growing of forests and maintaining the supply of forest products, there seems to be no reason why farmers, as one class of owners, should be favored over others in assistance in woodland management. Indeed, the large commercial owner might make more effective use of the assistance given, since his management applies to a wide area.

Fundamentally, commercial woodland management falls outside the field of the agricultural extension system as now organized. On the farm the woodland management is a part of farm management, which involves many other activities. The farm woodland should presumably take its place in proper balance with all the other work. It was for this reason that administration of the Federal act was placed in the Federal agricultural extension services, in order that farm advisers in forestry should be fully acquainted with the business of the farm as a whole.

In other words, commercial woodland management falls more particularly within the sphere of the Forester. From that aspect it may be argued, theoretically at least, that foresters might be detailed for extension work in that field either by the State or by the Federal Government, at nominal cost or no cost to the owner.

Arguments in favor of this proposal are that it is in accord with similar advice and assistance given to farmers regarding production of agricultural crops, livestock, etc., and to other industries regarding their particular lines of production. Probably the chief reason why the case has not been pushed much farther along has been merely the present lack of active interest in growing forests. The American people have only in recent years begun to appreciate that trees are a crop subject to arts of management and marketing similar to those of successful agriculture. Even after the word "forestry" had become firmly established in our vocabularly, it was popularly thought to mean only the preservation of existing forests or the planting of new forests. Its primary meaning is not yet commonly grasped, namely, the management of forest land so as to provide for both the harvesting of forest crops and the perpetuation of the forest by natural processes. Improvement of silvicultural, manufacturing, and marketing practices—in short, improved management—is a most urgent need. Forest lands in permanent private ownership should be synonymous with forest lands that pay their way. Because we have little background of experience in forest management, information as to the best practice is far less general than in the growing of farm crops, and a far-reaching scheme of aid is greatly needed if forest lands are to be made economically productive and self-supporting.

Against the proposal for more Federal aid in the form of forestry extension there has been offered the general argument that forest landowners should pay for such services, and objections have been heard from consulting foresters that public assistance at less than cost would mean unfair competition. The answer to these questions must hinge on the magnitude of the public interest at stake, and on whether individual owners can afford to pay for the services.

That the public is interested in keeping forest lands productive is a truth that might be endlessly reiterated. It is also true that a large percentage of the country's forest land is now so badly depleted of merchantable stands and good growing stock that its owners are unwilling to make even moderate investments in its management. It is not believed that the majority of forest owners, particularly of small tracts, can afford to pay adequate fees for the advice needed for management of their lands. As forest management develops, through public intervention or otherwise, and where exhaustive examinations are required or large tracts are involved, there is the distinct possibility that the practice of the consulting forester will tend to increase; but in the meantime there is a great need that should be met by the less intensive and lower-priced services that the public only is in position to furnish.

Extension work consists, of course, of making known to those in position to use it the results of research and experience. The Federal Government may proceed to carry the results of its work into woods practice either directly or with the help of State extension personnel, including State foresters, or, preferably, by both methods. Certainly, it seems that State organizations directly responsible under existing law for taxation systems, fire control, and other matters affecting the growth and utilization of forests should properly engage in the extension of knowledge of how to establish and manage forests. On the other hand, there are phases directly relating to the Federal Government's own research and practices in which extension work can probably be best carried on by the Federal organization.

FEDERAL AID IN RESEARCH

Research is a necessary part of the establishment of forests and the management of forest land. In every phase of the work—the collection of seed, the planting of denuded areas, the establishment of natural conditions favorable to tree growth, the protection of the stand, the cutting, manufacture, and conditioning of wood for use—success must depend on definite scientific knowledge. The scientific data of American forestry are as yet all too scanty. If, therefore, the Federal Government engages in any phase of forestry, research becomes properly a part of the effort.

It is not necessary, however, that the Federal Government spend funds specifically for research in the program of State aid. Present Federal legislation for aid in protection, planting, extension, and education allows for research work by the States along the particular lines of work appropriated for. States cooperating under section 2 of the Clarke-McNary Act can use Federal money in research work for fire control on the same condition as in fire control itself, i.e., upon approval by the Federal agency of projects undertaken. The same is true with reference to research in connection with planting and extension work. Should any other lines of Federal aid be undertaken, similar provision should and doubtless will be made. In view of this probability, there would seem to be little need of specific legal provision for Federal aid in research as such.

INVESTIGATION AND CONTROL OF FOREST INSECTS

NATURE AND EXTENT OF INSECT ATTACKS

Forest tree insects are usually heard of only when an epidemic breaks out. Hence they are thought of ordinarily as existing only in an epidemic stage. Quite the contrary is true. Scattered through the forests at all times are the same tree insects which form insect epidemics, but these are normally in a quiescent or so-called endemic stage. In this stage the insects play a normal part in the life history of the forest by killing trees weakened by other causes such as old age, lightning, or disease.

At any time, in either hardwood or coniferous forests, owing to factors such as a favorable season, dearth of natural enemies, or the like, some species of forest insect may increase with tremendous rapidity and change the infestation from an endemic to an epidemic stage. During the epidemic stage the insects are capable of covering many square miles or several States before natural causes intervene to restore normal conditions, after terrific losses have been incurred in forest values. The pine beetle epidemic in 1910–11 destroyed timber valued at millions of dollars in the Southern States. The larch sawfly epidemics practically wiped out the merchantable larch in the entire Lake States. The spruce bud-worm epidemic has caused immense losses in the spruce-fir forests in New England and Canada.

The great areas covered by individual insect epidemics necessitates something more than action by individual States. It is obvious that the effort and expenditure of one or more States may be completely wasted unless adjacent States give needed cooperation effectively.

CLASSES OF CONTROL WORK

Forest insect control may be divided into (1) investigative work on life history of the insects and their predators; (2) extensive insect survey work carried on constantly to locate insect epidemics in their incipiency and to furnish continuous information on changes in the various stages of each forest insect infestation; (3) control work proper, when the insects start or have started an epidemic, to check the spread of the epidemic.

The investigative work should be carried on by a corps of experts employed throughout the year. The extensive survey work need not be done by specialists but could be handled by rangers, wardens, or others familiar with general woods work, after a small amount of special training. Many States now have fire protective organizations in the field that would be useful in this type of insect work. In addition, some general supervision would have to be provided through either Federal or State agencies properly coordinated. Constant extensive insect survey should result in the location of forest insect infestations in their earliest or strictly local stages. In this stage local forces should do all in their power to stop them. Such control work is often very effective. It may usually be done before or after the fire season and, like the survey work, may be handled to a large extent by present State and private fire organizations.

CONTROL OF EPIDEMICS

When the epidemic is beyond local control, an emergency is presented which necessitates cooperation by the Federal Government with the States affected and threatened.

Whatever work is deemed necessary should be done on the same basis as fire-fighting work on Government land. Forest insects during a rising epidemic may increase at a ratio of 10 to 1 between the brood of 1 year and the next. A ratio of 5 to 1 each year is perhaps the average during the rise of an epidemic, which may extend over several years. The economy of doing control work when, say, 1,000 insects are active as against the next season with 5,000 is obvious.

Control of insect epidemics must apparently be undertaken by the Federal Government directly if effective action is to be had. It is impossible to estimate for annual needs of this kind as accurately as for fire control, because the variation in need is much greater, and it is therefore hardly logical to expect State organizations to deal with such epidemics as adequately as with fire or with insect survey and local control. Insect epidemic control must seemingly be conducted on much the same basis as control of dangerous infestations of farm crops by parasitic insects. There are many precedents for such action, of which the provision of Federal appropriations for control of the corn borer is well known. Federal appropriations to date for corn borer eradication approximate $18,000,000. The work was handled directly by the Federal Government, with such

State and private cooperation as could be administratively obtained, and without any legal stipulation as to State financial participation. The conditions of State cooperation should be left to the responsible judgment of the Federal agency administering the act. Usually they should be so administered as to require substantial cooperation, both in fairness to the United States and on the general principle that unless the State or the owners are interested enough to assist in work for their own benefit, it may not be worth doing at all.

On the whole it appears that continuing Federal aid on a fixed ratio of cooperation is applicable only to the survey and local or initial control of insects. Outside these activities, the factors affecting Federal aid in insect control seem comparable to those influencing Federal action in other emergencies, with the further proviso that some insects attack only trees of merchantable or nearly merchantable size, and in those cases greater emphasis should be placed on State and private contributions in control projects.

INVESTIGATION AND CONTROL OF TREE DISEASES

A prerequisite for disease control is research. The Federal agency is in the best position to carry out research on diseases of importance in several States. This is particularly true for introduced epidemic diseases, which are more destructive in States other than the one first invaded. On the other hand for native diseases of particular importance to individual States, study by State agencies is considered appropriate. The best solution of some of the more important problems could be obtained by cooperative research by State and Federal investigators. While State work on some types of forest pathological problems may properly be assisted by Federal contribution under the Hatch, Adams, and Purnell Acts, the central Government under the provision of the McNary-McSweeney Act proposes to make its principal contribution to such research by placing pathologists at its regional forest experiment stations.

There is also particular need for direct Federal aid in protecting the States from introduced diseases. Federal quarantine against parasites from other countries is necessarily a larger part of the protection system for forest trees than for crop plants. Federal activity is also essential in handling such introduced parasites as may slip through quarantine, since such work must often be done in one State primarily for the protection of the interests of another, and because only the Federal Government can maintain the mobile force of technical men necessary for prompt attack on an epidemic wherever it may appear. But where direct control measures are required, authority to condemn and destroy property is commonly necessary; this calls for State legal action, and, therefore, State cooperation. In securing concerted action against an invader that has already become established, as the white-pine blister rust, Federal leadership has proved invaluable to the State and private agencies that do most of the control work.

Native diseases in general do not ordinarily cause spectacular epidemics or threaten neighboring lands as do fires or insect outbreaks, and the application of preventive measures is therefore more properly a matter for the landowner. But since preventive measures have not reached the rule-of-thumb stage, there is need for a technical service force to help landowners translate the results of the research workers into practical operation. Such service should be developed on a cooperative basis by Federal and State agencies in much the way as in the case of blister rust; the method is discussed more fully under the subhead Service Force for Control Application in the section covering Protection Against Forest Diseases under "National Programs Required and the Responsibility for Them".

PROPOSED FEDERAL AID IN LAND ACQUISITION

Large areas of land throughout the country, and particularly in the South, the West, and the Lake States, will apparently come into State and county ownership for taxes now delinquent. Some of this land can be sold again only for amounts less than taxes accrued against it. Most of it is in too poor a condition to warrant serious interest in its improvement by private owners. If it is held subject to resale, a continuous impoverishment will likely result through purchasers removing any values that have accrued and letting it again go for taxes. Whether or not the States make provision for it, many of them will be forced into permanent land ownership and management designed to build up values, or else intermittent public and private ownership with inevitable destruction of values will ensue.

To accept the first alternative and avoid the second will involve large expenditures of public moneys, which may be hard to find. There may likely be large additional areas of land which through adjusted taxes and public assistance can be held in a reasonably permanent status of private ownership, but which for administrative or other reasons should be publicly acquired. This can be accomplished through the Federal and State Governments acting independently or through joint financing of the acquisition, the subsequent management title resting with either agency. Programs of Federal aid embodying this idea are now being prominently advocated.

It is likely that the proposed Federal aid would stimulate State expenditures for acquisition to some extent. It is also certain that under present conditions the greater part of any Federal appropriation made available would be taken up by those States which have made most progress along forestry lines and which therefore are not in greatest need of aid, unless provision were made for application of the funds only to the States which have made less progress along this line.

The prospect as a whole is difficult and rather unattractive. Recognition of the principle of Federal help to enable States to acquire forest land might possibly lead to the thought that if it is proper for the Federal Government to pay part of the cost, it might pay it all, and this, in turn, to demands from States unable or unwilling to acquire land that Federal properties be turned over to them if or when they contain values that can be removed at a profit. Nothing is to be gained through public ownership unless the public is prepared properly to care for properties acquired, and the test whether it is so prepared can well rest on its ability and willingness to acquire it by its own efforts.

FINANCING THE FEDERAL AID SYSTEM

When the Clarke-McNary Act was under consideration, it was assumed that with a Federal contribution of 25 percent of the cost of fire protection, States and private owners would be able and willing to supply the remainder needed. In the aggregate, private owners were counted on for one half the cost.

Fire protection systems had already been started in the majority of the forested States. In the Pacific coast and northern Rocky Mountain regions private owners had organized fire protection associations and had extended protection over a large percentage of forest lands, being aided only to a small extent by the States. In the New England and Middle Atlantic regions and in some of the States in other regions, protection organizations had been set up at public expense and were giving a degree of protection to part or all of the forest lands within their boundaries. In some of these States the system of State protection followed previous partial protection by owner associations. In States where no protective systems existed or only a beginning had been made at the time Federal cooperation was initiated, the Government has encouraged activity by matching State and private effort dollar for dollar up to a certain minor percentage of the total amount estimated as necessary. Under this stimulus much progress has been made in the setting up of State organizations, the arousing of public interest, and in actual extension of protection, but there still remains approximately 190 million acres without any form of organized protection. Most of this area lies within the States where protection work has started since the passage of the Federal aid acts, and on a considerable percentage of the land under organized protection the quality is far from adequate.

Those familiar with the work are agreed that satisfactory progress in fire protection may be expected in the New England, Middle Atlantic, and Lake regions, in those States north of the Ohio River in the Central region, and possibly in California, with a 25 percent Federal contribution. In the South and the Central States south of the Ohio River there is a very large acreage of cut-over lands that are relatively unattractive for private ownership and investment. From a careful consideration of the various factors involved, it seems reasonable to expect that with properly directed public cooperation the private owners in this part of the country might supply about 20 per cent of needed effort through cash contribution and other direct aid toward State-wide systems of protection, leaving the balance to be shared between State and Federal funds.

In determining this estimated percentage, the following factors have been considered: (1) The area of land containing marketable forest products; (2) the area of land containing young growth that is approaching merchantable size; (3) the demonstrated or probable interest of landowners in the establishment of forest stands on cut over areas; (4) the risk of loss from fire; and (5) the sums now being advanced by landowners for organized protection. These factors, of course, vary greatly by States and the average figures cannot be uniformly applied. In the Southern and the Central States private expenditures for organized protection are much less than the 20 percent estimated as possible. There is in total, however, a large amount of effort being expended by individual landowners in the South to protect their own properties, and, with public assistance and encouragement, it is believed that this effort can be largely expanded.

The States here under discussion contain about 25 per cent of the country's population. Their citizens do about 16.5 per cent of the national retail buying and pay about 6 per cent of the national income tax.

About 50 percent of all of the forest land of the country is in these States and to extend thorough protection over the whole area at this time would probably cost as much as to protect the remaining forest area. Fires running over forest land generally do much less damage to commercial stands than they do in the West and in some of the northern States, and the need to save the killing of young trees in order to provide a future stand is never as keenly felt by either the landowner or the public as the need to save timber of larger size. These States are generally finding it difficult to raise sufficient funds for governmental and social-service functions, and it appears unlikely that they can within the next 10 or 15 years provide funds for adequate State-wide protection systems. Until such systems are definitely set up, the maximum of private effort cannot be developed.

In the Northwest, where about half of the privately owned forest land has not yet been cut over, private owners have been paying the larger share of protection expenditures, and it is believed that as an average about 40 per cent of the needed funds will be supplied from this source during at least the next decade. Three of these States are paying for the protection of a relatively large area of State-owned lands but contribute very little to the protection of lands in private ownership. The analysis indicates, however, that if the Federal share is increased to 25 percent of the total fund required, the States are financially able to supply the remainder.

It must be emphasized that such calculations cannot be taken as more than very broad indicators of ability to finance protection. There are many other considerations which will seriously impair their application to individual States. It is, however, believed that they are of some value in an attempt to arrive at an estimate of possibilities.

It should be stated also that theoretical calculation of ability to pay or comparative actual capacity to pay, if it were known, would not constitute an accurate index of what will be done.

Obviously, what any State spends for care of its forest resources will depend largely on how it regards the need for such expenditures in comparison with other needs. It appears that the older States, whose virgin forest were largely cut over before exploitation in the South and West began, have more fully realized the need for replacement and care of this resource and are inclined to give it a higher priority than those States where exploitation of virgin stands is still going on or has only recently been completed. These indications serve to emphasize the fact that a Federal-aid system can advance only at the rate that the cooperating agencies are ready to advance, and that State responsibility and State participation through tax-raised funds should be emphasized in future administration of the act.

THE FEDERAL RATIO

In the apportionment of money in all forms of direct Federal aid to States some general formula has been applied, and it does not appear practicable to depart from this principle, excepting perhaps temporarily. Therefore, the rato of Federal to State and private funds in the underfinanced States cannot well be increased without also increasing it in those which have demonstrated ability and willingness to provide needed funds under the present arrangement.

A practical question for consideration then is, What would result through a departure from the concept that the Federal Government should contribute not to exceed 25 percent of the funds needed in any State and should adopt a plan whereby the Federal portion would be increased? Or what if the legal limitation of 50 percent sharing were itself removed? The problem, it must be remembered is to lay down a general rule which will be automatic in action and not appear to involve arbitrary favors to particular States.

The present policy of the Bureau of the Budget is to approve Federal appropriations for 1 year equivalent to 25 percent of total expenditures in the last, and recent appropriations have been largely so determined. In allotting the funds the Forest Service now matches State expenditures dollar for dollar only up to 8 or 9 percent of the adequate amount, leaving the remainder to be distributed on a pro rata basis.

If it is desired to make the Federal contribution larger in cases where it is more needed, that could be done either through raising the basic 25 percent budget ratio or through adopting a plan whereby each State would be allotted an amount up to the full 25 percent of adequate funds, as fast as it could match the Federal contribution dollar for dollar. Under such an arrangement the States could now match approximately $1,000,000 more than the 1933 allotments. Of the million dollar increase, approximately half would be taken up by States that are in especial need of assistance. The remainder would serve to supply all but 2 or 3 of the other States with the additional funds needed for protection (as shown by the 1930 estimates), provided they maintained their own last 5-year average appropriations. A few States might decrease their own appropriations. From theoretical calculations it appears that this possible decrease in State appropriations might amount to approximately $250,000. Under this plan, therefore, with a Federal increase of approximately $1,000,000, total expenditures for protection would be immediately increased by about $750,000.

If, instead of this plan, one were adopted of allotting to States an amount equivalent to State and private expenditures but not to exceed one half of total needs as shown by the 1930 estimates, an increase in the Federal appropriation of approximately $2,500,000 would be indicated. But the net increase in total State and Federal expenditures together under this plan would seem to be little greater than from the other, because the first method would furnish sufficient Federal funds to bring up to a full adequacy status most of the States whose expenditures are sufficient to enable them to take full advantage of it, and it would make available to the others all they could now take on a share-alike basis with current appropriations.

The advantage of the second plan is that it would allow, under existing law, the allocation of the maximum of Federal funds to the States where Federal aid is most needed. Its disadvantages are (1) that it does not constitute an entirely sound Federal fiscal policy because it sets up estimates rather than actual expenditures as a basis for the division of Federal funds between the States, and (2) that it does not constitute a Federal program for complete protection, since it would carry protection in the now greatly underfinanced States only to the point of 50 percent of needed funds. After that point had been reached, all of the remainder would have to be supplied by the States and the landowners. It would, however, serve to advance the work during the next decade or more as fast as any other plan that has been suggested, and, since there are so many influences that cannot be accurately appraised as this time, it seems impracticable to attempt to provide for them too far in advance.

Should the Federal Government desire to participate in protection to a greater extent than the half sharing now allowed by law, but with the authorization limit of $2,500,000, the total expenditures in some of the States could obviously be increased without exceeding estimated needs. If, for example, a ratio of 75 Federal and 25 State and private were used, the amount expended would be doubled in the States most needing protection as compared with results under the first plan discussed. To do that, however, would require a Federal appropriation of approximately $5,000,000, an amount exceeding that required under the first plan by about $2,500,000, with a resultant total increased expenditure for protection of only about $1,000,000. Aside from this consideration, common business foresight demands that the ratio of Federal participation in protection should be balanced by assurance of results from money expended. Assumption of all costs can be balanced only by complete control, and that can be had only through ownership or strict regulation of use. Assumption of a high percentage of protection costs requires corresponding guarantees as to permanency of the protection project. It is believed that guarantees as to protection alone will not in any case warrant a Federal sharing of more than 50 percent of the cost, and that as a general average the Federal percentage should be less than that amount.

Adherence to the latter policy apparently calls for either a large program of Federal acquisition, or public regulation, Federal or State, or both, if complete protection is to be reached within the near future. The possibilities and merits of public regulation and Federal ownership are discussed in other sections of this report, and conclusions as to a plan of procedure will be drawn in the program section.

The above discussion of the financial aspects of Federal cooperation and the comparisons made in it are limited to the subject of fire control. The Federal aid system now includes planting and management of farm woodlands and shelter belts, and other forms of Federal aid are in prospect. The relative need for those activities in the different States does not necessarily conform to the relative need for fire protection. In several of them, however, the needs are closely parallel, and in view of this fact and the fact that the total of other forms of existing and proposed aid is small in comparison to the cost of fire protection, it is believed that the considerations presented are applicable to the situation in toto.

STATE AID

By H. J. Eberly, District Forest Inspector

In the preceding discussion the advisability of and justification for Federal aid to the States in forestry have been pointed out in some detail. Passing from the sphere of Federal action to that of the individual States, it is found that the same considerations apply largely to the question of State aid to counties and to private owners. For example, it is good business for the State to have its forested counties grow timber supplies for its agricultural and industrial sections. Likewise, a forest insect epidemic originating on one privately owned body of timber will pay no regard to property lines or county boundaries, and therefore State action becomes necessary to safeguard the general interest.

STATE FORESTRY LEGISLATION AND APPROPRIATIONS

State interest in private forest resources is not an idea of recent times. Protection and supervision of forest lands has long been accepted as a proper function of State government. As early as the seventeenth century, forestry and timber problems claimed the attention of our colonial legislative bodies. Prior to the establishment of our National Government hundreds of laws dealing with the use or care of forests had been placed on the statute books. Most of the Colonies gave legislative recognition to the menace of forest fires. These early statutes, however, were of regulatory nature only and were chiefly directed toward the protection of public and private property in merchantable timber and improvements.

No State had enacted legislation providing for the establishment of forestry departments or had provided funds for fire control until the latter part of the nineteenth century. The States which pioneered in making funds available for the protection of their forest resources were Minnesota, New York, California, and Pennsylvania.

Minnesota in 1876 appropriated $2,500 to be expended as premiums for the planting of forest trees, to aid an association of private forest owners. In 1895 a forest commission was created, with duties of preventing and suppressing forest and prairie fires. Expenses of such work, to be paid by the State, were not to exceed $5,000. New York in 1885 appropriated $15,000 for fire protection and sundry forestry purposes. California in 1887 appropriated $15,000, part of which was directed for use in fire prevention. Pennsylvania in 1897 provided for fire extinguishment, with payment shared equally by county and State. The county cost was limited to $500 annually.

By 1911, 12 States were expressing interest in their timber resources to the extent of making available a total of $165,975 for forestry work. Since that time, interest in forestry has been so largely expanded that at present 45 States are recognizing certain responsibilities in the work. Their interest, extending both to private and to State-owned forest lands, finds its most direct measure in the amount of State funds made available, which at present amount to more than $7,800,000 annually. This figure is taken from the latest State budget expenditure estimates submitted to the Federal Government. The following summary helps to visualize the character of the several projects which the State aid funds support and develop:

	Percent of estimated expenditures
1. Administration	7. 6
2. Protection:	
Fire	41. 5
Disease	1. 9
Insects	2. 6
3. Reforestation and nursery work	14. 5
4. Purchase of forest land	15. 7
5. Maintenance and improvement of State forest land	12. 0
6. Research	1. 2
7. Education	1. 6
8. Extension	1. 4
Total	100. 0

Of the above expenditures, the part applying directly to forest projects on State lands is estimated at 35 percent, which largely constitutes State forest acquisition, management, and planting. The character and extent of the aid which is being extended by the States to private owners is discussed under a separate heading.

STATE INTEREST IN FORESTRY

The concern of the State in the protection and perpetuation of its private and public forest properties is even more direct than is that of the Federal Government. This concern is reflected in the actual amounts of State funds now being made available for fire protection, planting, extension, forest insect control, etc., which are considerably in excess of Federal aid. With State and private ownership embracing 82 percent of the Nation's forest area, the States' responsibilities in doing everything possible to protect and encourage the most productive use of this large area are clearly evident.

In 30 States the area of State and privately owned forest lands comprises 25 percent or more of the total land area. In these States the proper use of forest lands is a major factor of the land use problem as a whole. The drag of idle, unproductive land affects the economic welfare of all citizens, and the regrowth of forest crops on cut-over lands offers at least a partial solution of this difficulty.

It is clearly evident that continuous productive use of forest lands is necessary to enable the forested States to attain their maximum degree of economic and social development. In the majority of States, private forest lands constitute a vital component of the tax base. To the taxable assets of forest lands and timber as such are to be added those of sawmills, pulp and paper plants, and kindred manufacturing establishments, as well as logging equipment, railroads, and the like, all of which combine to form a most imposing aggregate of revenue-producing properties.

Employment of labor is recognized as the vital index of economic health. The harvesting and manufacturing of products from the forests provide a large share of the employment of labor in practically all States, and in several States the lumber industrial pay rolls exceed all others in numbers of men employed and wages paid.

FACTORS AFFECTING STATE ACTION

PUBLIC USE OF PRIVATE LANDS

Public use and abuse of millions of acres of privately owned forests constitutes one of the major justifications for State participation in extending aid to private forest owners. Public interest in forest protection is an obligation commensurate with the use of privately owned land by the public. In addition to timber production, forests usually provide hunting, camping, and scenic attractions, which in most regions extend beyond the owner's immediate advantage and carry over to the general public. In a State where public use of State and private forest areas contributes materially to the pleasure, profit, and well-being of its people or where forest areas are of sufficient attraction to bring in many citizens from other States, then making State funds available to insure the continuation of these benefits becomes at once a desirable and necessary State function of public service.

In most forested States little or no regulation against trespass is exercised by the private forest owner against the public which comes to use and enjoy his lands. Such public use carries with it dangers over which the owner alone has little control, and since the public has the enjoyment, it is justifiable for the public to pay for such abuse as may result. Carelessness with fire constitutes the chief danger and abuse, and it thus becomes a proper function of the State to extend aid not only to reduce this community hazard by legislation and police functions directed at the origin of forest fires, but also to aid the landowners in the costs of fire patrol and suppression.

CONCENTRATION OF WEALTH

The geographical distribution of taxable wealth within individual States is very unequal. Therefore State aid becomes highly necessary as a stabilizer of State-wide development and prosperity. This fact is most strikingly evident in States having large areas of cut-over lands. Many counties once rich in valuable stands of timber, saw mills, lumbering communities, and forest pay rolls are now poor. Although they once produced a large portion of the State's revenues and contributed materially to its prosperity, they are now unable to carry on their own functions, and must have State aid. The burden is therefore shared by the industrial centers and counties that have succeeded to greater wealth and prosperity. The fullest recognition of this factor of State aid is seen today in those northern and eastern States which were earliest cut over and which are now great centers of wealth and industrial development in other lines.

RELATIVE DESTRUCTIVENESS OF FIRES

One of the most important factors affecting State interest and aid is the extent to which forest fires endanger and destroy life and property. The damaging effects of fire differ greatly in different regions. For example, holocausts have occurred in the Lake and Western States. Towns have been wiped out, people burned to death, game destroyed, and whole stands of merchantable timber killed. The fire danger is so great in these regions and so seriously affects the life and prosperity of citizens and the welfare of the States as a whole, that public safeguards are generally recognized as essential.

Fire in the Southern States, on the other hand, seldom causes loss of life, and damage resulting from fires occurring during certain seasons of the year is often not readily apparent. In regions where fires do less visible damage, the people feel less need for taking public action than those in States of greater fire danger. Here the damaging effects of fire become a relatively less important factor of State concern and action.

The importance of fire protection has been particularly stressed because it is one of the most pressing forestry problems and practically all other field work in forestry is dependent for successful achievement upon the adequate control of fire. However, if States are earnestly concerned in promoting forest practices on privately owned lands they should not stop with fire protection. Both financial and legislative action needs to be provided by the States for other important forestry work such as forest insect and disease control, forest research and extension, planting, etc. The preceding part has dealt in considerable detail with these other important factors and has outlined the parts the Federal Government and the States should play in developing means for promoting and maintaining adequate measures of control.

TAX DELINQUENCY

Another factor which will undoubtedly have a far-reaching effect upon State action in forestry is that of tax delinquency. In those States where large areas of private forest lands revert to the counties or States because of tax nonpayment, public action in forestry must necessarily result. This action may find direct financial expression or it may result in legislative action aimed to reestablish or maintain the private owners' interest in his cut-over lands. The Oregon, Washington, and Idaho reforestation laws and the forest crop laws of the Lake States are samples of this State legislative interest and action in forestry brought about by tax delinquency of private forest lands.

CONCLUSIONS

In summing up the factors influencing State aid, it appears that the two most important are, first, the relative damage which fires may do to life and property, and, secondly, the ability of the State to pay and to take legislative action necessary for control of the situation. The factor of fire damage is not here interpreted as constituting damage to timber values alone, but includes all other damage such as the detrimental effects on recreational use, hunting, stream flow, regulation, etc. As these effects of fire become better understood and appreciated as detrimental to the propserity and happiness of the people, then public action may be expected to follow.

The extent of this public demand and financial support will, of course, not be uniform. In the Lake, Middle Atlantic, and New England regions, particularly, individual States are manifesting in a substantial way, both in funds and in legislation, their public interest in forestry. This public desire appears firmly established and may be expected to grow and result in future continued and increased public participation. In the large pine and hardwood areas of the South, the factors of fire damage are not as striking as in the Lake or Pacific Coast States, and neither are the States as wealthy and therefore able at present to manifest as great a public financial interest as some of the richer industrial States. In the South, as elsewhere, increased State participation will largely result from a better financial situation and from a better realization of the use and value of second-growth stands.

NATIONAL PROGRAMS REQUIRED AND RESPONSIBILITY FOR THEM

The preceding discussions have presented the essential facts of the forest land and timber supply situations, the status of forestry on public and private lands, and the present degree of public aid and control extended to private forestry. The following sections endeavor to outline the programs of action which must be initiated in all branches of forestry in the near future if the obvious requirements of land use and timber supply are to be met successfully. These programs cover a wide range of activity, but with a unity of purpose that serves to combine them into a broad national plan. The final section brings together the costs for all programs, and develops ways and means of financing public programs. Division of responsibility for forest activities and needs is discussed, and the legislation needed to carry out the different forestry programs is summarized.

THE AREA WHICH CAN AND SHOULD BE USED FOR FORESTRY

By C. Edward Behre, Director, Northeastern Forest Experiment Station, and
E. N. Munns, Chief, Division of Silvics

CONTENTS

Page
The total area available for forestry 1231
Objectives in forest land use 1233
The land needed for forest uses 1233
  The land needed for recreation 1234
  The land needed for watershed protection 1234
  The land needed for wild life 1235
  The land needed for range and livestock 1235
  The land needed for timber production 1235
Balancing forest-land use objectives 1238

THE TOTAL AREA AVAILABLE FOR FORESTRY

To estimate the area in the United States that is available for forestry, it is necessary to review acreage totals developed in preceding sections. In the section, Forest Land, the Basic Resource, commercial forest land has been estimated at 494.9 million acres after allowing 11 million acres as reserves for parks and other purely recreational, educational, or commemorative purposes. Chaparral, open woodland of stunted trees, and other forest land chiefly valuable for other purposes than timber was estimated at 108.7 million acres, largely in the territory bordering the deserts and in the alpine zone in the high mountains. Although this area has little potential commercial value for timber production, much of it has considerable or high economic value for the protection of watersheds, as range for livestock, as a local source of fuel wood, fence posts, etc., or it may contribute substantially to the scenic attractions of the country. These estimates bring the total of forest land in the United States at present to 614.6 million acres. To estimate the total for the future, certain trends in land use must be taken into account.

For a number of years land used for agriculture has been showing a net decrease. It is true that even in sections of the East abandonment of some lands is being offset by the clearing and cultivation of others; but the trend is very clear in all sections east of the Great Plains. As estimated by the Bureau of Agricultural Economics in the section, The Agricultural Land Available for Forestry, 51.7 million acres in the forested country of the East now included in the agricultural classification is available for forestry. About half of this area (25.7 million acres) is at present classified as crop lands on abandoned farms, 11 million acres is idle or fallow crop land on operating farms, and 15 million is in unplowable pasture essentially submarginal in character. In addition it is estimated by the Forest Service that 3 million acres of treeless land in the region not covered in the section referred to will support tree growth if planted and that distinct social and economic advantages may result from devoting it to forestry.

The section, The Agricultural Land Available for Forestry, states further that, should present trends continue for several decades,

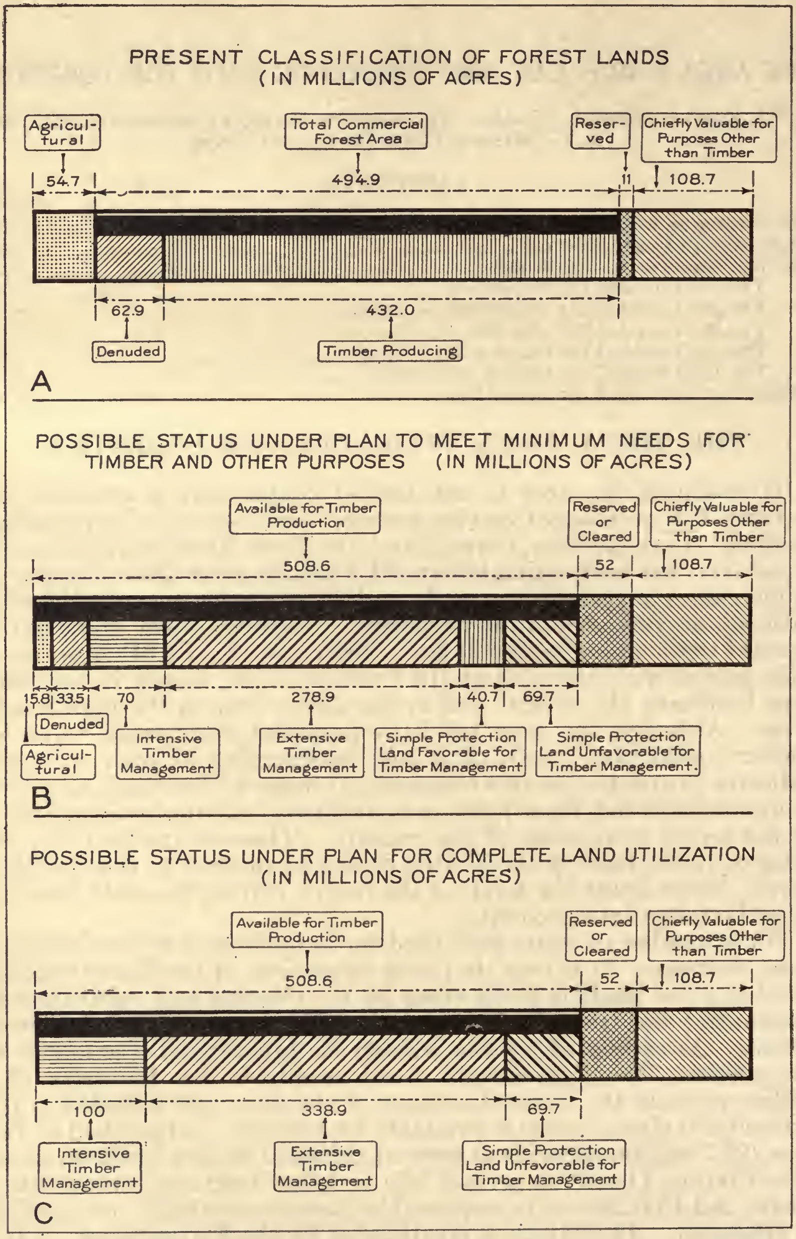

FIGURE 1.—Present classification and possible future status of lands available for forestry, 669.3 million acres.

another 30 million acres of agricultural land in the East may become available for forestry in the future. On the other hand to meet the ultimate agricultural needs of the country no net decline in agricultural area in actual use may be expected. In fact, an increase of some 20 to 35 million acres of agricultural land may be needed if technological developments do not keep pace with recent trends. The agricultural area probably needed to offset the continuing abandonment of submarginal farm land in the East will come in part from extension of farming in the central treeless region, in part from development of irrigation projects, and in part from clearing of forest lands on productive soils. Most of this clearing will probably take place in the hardwood lands of the Mississippi Delta, but some may be in the West, chiefly west of the Cascade Mountains. Such clearing in the West is continually in progress on a limited scale and since it is not offset in any appreciable degree by farm abandonment, it is estimated that a reduction of perhaps 2 million acres should be made from the present forest area in the West.

Because of these compensating factors and the uncertainty concerning the actual balance in the future, the 30 million acres of agricultural land which may still become available for forestry are not included in the area definitely available, but may simply be considered as possible reserve.

When these immediate possibilities are brought together, the net total area now available for forestry in all its phases amounts to 669.3 million acres. The present classification of lands with respect to forestry is shown in figure 1, A.

OBJECTIVES IN FOREST LAND USE

The earlier sections of this report, particularly the sections Is Forestry Justified? and The Present and Potential Timber Resources, have developed the possibility of two objectives in the use of land for forest. One is concerned wholly with the ills that grow out of permitting large tracts of idle and neglected land to accumulate, and envisions converting to some type of forest growth every possible acre that cannot be used to better advantage for other purposes. The other objective is determined by the country's need of forest products and services and involves the determination and development of a forestry program that will utilize the available forest area to the best advantage in producing a sufficiency of products and services.

If the available land is not sufficient to satisfy the need for all purposes, then the two objectives will be identical. But in a young and not very densely populated country, it is quite possible that the second objective may be met without fully realizing the benefits of the first. If this is the case, an attitude of complacency is likely to appear and the Nation may be blinded to the ultimate economic benefits inherent in full utilization of the basic land resource.

THE LAND NEEDED FOR FOREST USES

From the foregoing and because of the great public interest which surrounds the problem, it is desirable to consider how much land will be needed to meet requirements for various purposes. The various uses of the forest will overlap and interlock to a large extent and in general this is a desirable state of affairs. Only on a relatively small portion of the entire area will it be necessary to restrict use to a single purpose. The needs are summarized as follows from the various sections of the report in which the forest uses are dealt with in full detail.

THE LAND NEEDED FOR RECREATION

Recreation is here taken to include not only the use of the forest for camping, hunting, fishing, etc., but its preservation and use for aesthetic or educational purposes as well. This use is increasing, and will demand much larger areas in the future. In many places on well-managed forest areas, recreational use and commercial production can go hand in hand with only temporary set-backs to recreation as areas are logged. Near population centers, however, almost any forest may be so valuable for recreational purposes as to forbid even the temporary depletion of its aesthetic values that would be involved in cuttings under the best silvicultural practices. Strips of timber along roadsides may be reserved from cutting because their beauty is enjoyed by a much greater number of people than could possibly benefit by any commodity value they may have. Since any sort of cutting impairs or destroys many of the educational and inspirational values inherent in the primeval forest, it is also desirable to set aside certain areas to be kept as nearly as possible in their natural condition.

Altogether, probably 45 million acres of forest land should be withdrawn from commercial timber production and devoted primarily to recreation. Already 11 million acres of this total have been devoted to this use, leaving 34 million as the total net area of commercial timberlands which it may still be desirable to set aside.

Much of the high mountain country included in the noncommercial forest area has high scenic value and will serve recreational purposes. In the West a large part of the commercial area which may be included in additional recreational reserves lies high in the mountains just below the alpine zone. These lands as well as certain swamp areas of poor timber-producing capacity in the South which are also likely to be included in the proposed recreational reserve, are of doubtful economic availability, and relatively unfavorable for timber production even though classified as commercial forest. Because of their poor growth or relative inaccessibility the reservation of as much as 13 million acres of this sort will have little influence on the timber production situation. The lands set aside primarily for recreation will rarely, if ever, suffer any reduction in their value for protection of streams and soils or for the production of wild life.

THE LAND NEEDED FOR WATERSHED PROTECTION

Although the protection of watersheds and the prevention of erosion constitute perhaps the most important use of forest lands as far as public welfare is concerned, it will seldom be necessary to set aside land having other commercial values exclusively for such protective functions. Under proper control, the use of forest land for other purposes will generally be entirely consistent with the conservation of protective values. Steep slopes at the headwaters of important streams and areas especially susceptible to erosion are the most important types of land where restriction of commercial utilization will be necessary. The noncommercial forest area includes much high steep country in the alpine zone, and also large areas in the transitional zone between desert and commercial forest especially susceptible to erosion. Careful regulation of other uses, and especially of grazing, is essential on these areas.

Although some 449 million acres of the total forest area serves to protect our streams and soils, it will probably not be necessary to set aside more than 5 million acres from commercial timber use for protective purposes exclusively. Because of their location in mountainous areas where scenic values are high, possibly 1 million out of the 5 million acres will be included in the areas where recreational use will dominate. The net reduction of commercial forest area will, therefore, be about 4 million acres.

THE LAND NEEDED FOR WILD LIFE

Although increasing attention will probably be given to the control and protection of the wild life population in the forests, it should not be necessary to devote any areas to exclusive use for this purpose. Recreational or watershed reserves as well as noncommercial forest lands may well serve as special areas for the protection of wild life, or such special wild life areas may be established as needed elsewhere on the commercial forests, but this need not interfere with other use. It may, however, be necessary to restrict the grazing of domestic livestock to conserve food for wild life in special cases. Practically the entire forest area may contribute in some degree to the production of wild life of social or economic value.

THE LAND NEEDED FOR RANGE AND LIVESTOCK

More than half of the forest lands of the United States is used for the grazing of livestock. In the West and South most of this is in the noncommercial forest area or the more open forests of the yellow pine types. If properly handled, livestock can generally be produced on such forest areas without detriment to commercial timber production, protection of watersheds, or recreational use. Scientific control is necessary, however, to keep grazing within limits consistent with the maintenance of the other use values.

In the Central States large areas of hardwood woodland have been seriously deteriorated by grazing of domestic livestock. Although the practice has been carried to excess and eventually leads to the destruction of the woods so used, it has a limited place in the agriculture of the region. It, therefore, seems necessary to allow about a million acres reported as commercial forest land for pasturage of this sort, which in effect is devoting it to agriculture rather than forestry.

THE LAND NEEDED FOR TIMBER PRODUCTION

About 17.5 billion cubic feet per year may be set up as a reasonable minimum objective for a national program for timber production. This covers estimated normal timber requirements of about 16.5 billion cubic feet per year with a margin of safety of 1 billion cubic feet to provide for possible future calamities, such as the chestnut blight, which might wipe out entire species, and to provide for holding or increasing an export trade in forest products. A growth of this amount would probably yield about 60 billion board feet of saw timber, as against the estimated normal requirement of about 55 billion board feet.

It has been shown that current annual timber growth on the present commercial forest area, allowing neither for the withdrawals for other uses outlined above nor for doubtful economic availability of any of the land, is slightly less than 9 billion cubic feet, or hardly more than half the probable future requirements. To increase growth to meet future needs will call for a maximum effort by all agencies concerned. Part of the shortage will be made up by natural restocking of available lands now lying idle, part may be supplied by increasing the productive area still further by planting, but most of it will probably be brought about by building up the existing growing stock through better protection and more intensive management. Possible growth under three plans of using the land available for timber production is shown in table 25 of the section Present and Potential Timber Resources. The first of these has no bearing on this discussion, since it fails to meet either of the major objectives in land use. The second was based on a possible status of forest lands under the objective of putting all land to productive use and will be discussed later. The third outlined a situation under the objective of simply meeting the Nation's requirements for timber and other uses. The following paragraphs explain the basis for suggesting the distribution of land shown in the third plan as a reasonable possibility for producing the minimum safe requirements in timber growth.

INCREASE OF PRESENT PRODUCTIVE AREA BY NATURAL RESTOCKING AND PLANTING

What portion of the 117.6 million acres of open agricultural land and denuded forest land shown in figure 1 A will restock naturally can at best be estimated only very crudely. A compilation of regional estimates based on the best judgment of those who are familiar with conditions in each region indicates that 42.8 million acres, or a little more than one third of the whole, may be expected to restock in the course of 40 or 50 years to a degree which will make eventual commercial utilization possible. Much of this naturally restocked area will bear timber of poor quality only, but eventually this may be brought into a higher state of productivity. In any event all the land now open should be given the same protection from fire as other forest areas in order to give natural reproduction every possible encouragement.

Further extension of the productive area by planting will be desirable and necessary. Lands restocked in this way may generally be depended upon for relatively high yields and so will contribute substantially toward balancing the timber budget. Considering the land available for planting in each region and the relations to national and local needs, an immediate program for the planting of 25.5 million acres of agricultural or denuded land is deemed feasible. (See section The Reforestation of Barren and Unproductive Land.) It must be emphasized, however, that the planting of this area in any reasonable period of time will call for the best efforts of all agencies on a scale far beyond anything that has been envisioned nationally in the past.

Even with the total of 68.3 million acres thus added to the productive forest area, about 49.3 million acres might still remain open and nonproductive, divided between agricultural land now available for forestry and forest land now denuded, presumably somewhat as is indicated in figure 1 B. It is possible that watershed requirements might not be adequately met on the lands left idle and open in this way.

POSSIBLE FUTURE STATUS OF AREAS FOR MANAGEMENT

With the available productive area increased by natural restocking and planting as described in the preceding paragraphs, a total of 459.3 million acres is indicated as the area which will probably be involved in timber production. As pointed out in the discussion of Timber Growth in the section on Present and Potential Timber Resources, it is reasonable to expect that the management afforded these lands will vary according to the play of economic forces in relation to ownership, location, and productive capacity of the lands.

In the first place there are included in these 459.3 million acres considerable areas so remote with respect to economical development of transportation or of such low productive capacity that it is doubtful if they will ever become economically available. This comprises much of the rough and relatively inaccessible land in the high mountains of the West and in the Appalachian region which may not be included in recreational reserves. These areas for the most part are not only unfavorably situated with respect to cost of logging, but also bear timber of poor quality and relatively slow growth. In many instances, as a result of their treatment in the past, the stands are scattered, the trees are of poor form, or valuable species have been replaced by species of little value. Other areas of low productive capacity, although they may have supported a merchantable stand of virgin timber as a result of centuries of growth, offer very little prospect of producing another crop soon enough to be of assistance in balancing the Nation's timber budget. Many of the swamps in the Lake States, and certain poorly drained or infertile lands in the South, as in southern Florida, are in this category.

Altogether it is estimated that there may be 82.7 million acres relatively unfavorable for forest management in the present commercial forest area. Since 13 million acres of this is assumed to be included in the area proposed for recreational reserves, a balance of 69.7 million acres of this sort would remain in the timber-producing area. This land will not as a rule justify anything more than protection against fire and can only be counted on for a nominal amount of growth, estimated at about half a billion cubic feet per year.

On practically all of the remainder of the timber-producing land scientific forest management should be applied as rapidly and intensively as possible. But no matter how successful efforts along this line may be, there will doubtless always remain certain areas upon which no effort will be made to maintain or increase production. It may be expected that growth on these areas will be maintained about as at present by nature aided somewhat by the extension of protection. In order to give recognition to this situation, 40.7 million acres is classified as receiving only simple protection although favorably situated for forest management. Growth on these areas, calculated at the average rate obtaining at present in each region, amounts to a little over 830 million cubic feet per year.

Based on the foregoing assumptions and estimates, there would thus remain about 348.9 million acres constituting the area on which forest management of some sort should actually be applied. Extensive forestry, which simply prevents devastation through adequate fire protection and through cutting practices which insure reproduction adequate for commercial utilization, if applied to this whole area could be expected neither to yield sufficient growth to meet the indicated minimum objective for the country's timber needs on a quantity basis, nor to provide the material of large size and high quality which constitutes the bulk of interregional and export trade and always commands the highest price.

It is believed that possibly 25 percent of the total growth should be produced under intensive forestry in order to yield some 4⅜ billion cubic feet of saw timber for the more exacting uses. To do this would require about 70 million acres under intensive forestry, of which almost nine-tenths would probably be in the East. In consideration of the desirability of growing as much high-quality material as possible and the ultimate profit which will probably result from such a policy, this seems an entirely reasonable objective. The magnitude of the undertaking, however, may be judged from the fact that probably not over 10 million acres in the entire country are now included in plans calling for intensive management.

With the indicated area under intensive management, the remaining 278.9 million acres, if managed under extensive forestry, will make up the balance of the national requirements. Even this extensive forestry cannot, however, be achieved without widespread effort and a radical departure from the unsatisfactory practices which now prevail so generally. Under extensive forestry it is estimated that present growth rates will increase 50 to 200 percent in the various regions and that the total growth on the area which may be under extensive forestry will be about 11¾ billion cubic feet.

A hypothetical distribution of area and growth among the various regions according to the possible future status of forest management suggested in the preceding paragraphs is given in tables 22 and 23 in the section Present and Potential Timber Resources. It will be seen that the growth totals approximately 17.8 billion cubic feet, which is about the minimum safe objective to meet probable future requirements. The plan suggested represents a reasonable balance between the several means of relieving the shortage of timber growth. Its essential feature is that every possible means must be taken to increase timber growth to meet the needs and practical difficulties of the situation.

BALANCING FOREST LAND USE OBJECTIVES

The possible status of forest lands on the basis outlined in the preceding paragraphs is shown in figure 1, B. It appears that if adequate measures to safeguard and develop the resources for the various uses are made effective, the area available for forestry (667.3 million acres) is ample to provide for actual needs for all purposes as far as these can be foreseen. In fact, it may be possible to meet these needs without complete utilization of all the forest land now denuded or of all the agricultural land likely to be available for forestry. Presumably, through the operation of the economic factors, the lands which might be left idle will in general be the most difficult to restock or the least productive and least desirable of the open lands available.

But, as developed elsewhere in this report—particularly in the section Is Forestry Justified?—there are cogent reasons why the Nation should strive to attain the full benefits of putting all the available forest land to productive use, even though this offers prospect of going considerably beyond the minimum requirements for domestic use. Figure 1, C, shows the possible future status of forest lands, if all the available area were put to productive use in accordance with the previously mentioned second plan in table 25 of the section, Present and Potential Timber Resources.

Utilizing all the available area in this way will affect primarily the productive timber area. Since natural regeneration was included as an essential feature of the plan for meeting requirements shown in figure 1, B, planting will probably have to be resorted to, to bring the remaining area of idle land (almost 50 million acres) into production. It may be expected that a large proportion of the areas which may be planted will receive intensive management, so that if all the land is put to productive use, it seems reasonable to extend the area under intensive forestry to 100 million acres. This is in keeping with the thought that at any stage in development, there will be a certain economic balance between areas under intensive forestry and those under crude forestry or simple protection. All the remaining area available for commercial timber use, except the 69.7 million acres of remote or poor land which will always remain unfavorable for timber production, is assigned to extensive forestry in this plan, because by the time we may succeed in bringing all the land into productive use it is probable that forestry practice will be generally adopted. Figure 1, C, therefore, represents not only a plan for complete utilization of the land but also a possible ultimate practical limit in developing the growth potentiality of the land through forest management.

The only possible objection to working toward full use of the land is the possibility that this policy may result in an unmarketable surplus of forest products. But from the detailed discussion of the outlook for foreign markets as given in the section, Trends in World Wood Consumption, the likelihood of being able to dispose of a surplus such as that indicated, at the time when it may develop, is sufficiently strong to serve as an incentive toward every possible increase in potential growing capacity. Furthermore, to the extent that reforestation and the practice of intensive forestry are successful, it will be possible to take a liberal attitude in regard to the demand for lands for exclusive recreational use.

Another service which may justify public action in the reforestation of certain lands beyond the actual indicated needs for forestry purposes is the rebuilding of soils to provide for possible future demands of a larger population. A considerable portion of the area available for forestry has been used for agriculture in the past and is favorably situated for such use, but has lost its fertility through either misuse or erosion. Forest growth on such areas will in time restore the organic content of the soil and improve its physical condition so that in the future it may again support profitable agriculture.

But the present growth is so far short of domestic requirements that, if estimates presented in this report do not prove entirely unfounded, there is no possibility of developing an exportable surplus from current growth for several decades. As far as a program for the next 20 years or more is concerned, it therefore makes little difference which objective should be the ultimate goal. For either purpose, the need is clearly to drive ahead in all lines of activity in order to insure an area of sufficient size being made productive, to build up and maintain growing stocks which will give an annual yield far in excess of present growth, and at the same time to make as far-sighted provisions as possible for other uses such as recreation and watershed protection. The details and costs of such a program are developed in succeeding sections of this report. But even under the most favorable conditions as to public support and effective accomplishment, it is unlikely that a program sufficient to meet the needs for all purposes can be in full operation before the end of the present century.

FUTURE ADJUSTMENTS IN LAND USE AND OWNERSHIP

By Joseph C. Kircher, Regional Forester, Eastern Region

CONTENTS

Page
Anticipated shifts in land use — 1241
Anticipated shifts in forest land use and ownership — 1242
The need for immediate action — 1245
Land classification — 1246
Means available for effecting immediate adjustments — 1248
  Public domain adjustments — 1248
  Federal acquisition by purchase — 1248
  State acquisition by purchase — 1249
  Tax delinquency — 1250
  Exchanges — 1250
  Gifts — 1251
  Adjustments by private owners — 1251
Conclusion — 1252

ANTICIPATED SHIFTS IN LAND USE

Estimates summarized in figure 1 of the preceding section show the present forest area of 614.6 million acres to consist of 108.7 million acres of noncommercial forest, 11 million acres of commercial forest set aside for parks and other reserves, and 494.9 million acres commercial forest available for timber production. In addition, 54.7 million acres of agriculture land is shown as available for forestry.

The shifting of land use between agriculture and forestry is an exceedingly complicated and variable process. In the section, "The Agricultural Land Available for Forestry," it was stated that in most sections in the East clearing of new land for agriculture is going on at the same time that other lands are being abandoned. In the Northeast agricultural land has been abandoned on a tremendous scale during the past few decades, whereas clearing of new lands has been quite insignificant. In the Central States, an excess of abandonment over clearing has developed much more recently. In portions of the lower Mississippi valley the agricultural area has shown a net increase up to the 1930 census. The agricultural area now available for forestry represents an estimate of that portion of the lands abandoned in the past two decades which was not already classed as forest, together with land on existing farms that is now idle and not likely to be used again for agriculture.

Although the rate of abandonment may have been greatly reduced by the present economic depression, there is every reason to believe that a constant shifting of lands between agriculture and forestry will continue in the future much as it has in the past. The Bureau of Agricultural Economics estimates that by 1950 another 25 to 30 million acres of agricultural land in the East will become available for forestry. This cannot, however, be taken as a net increase in the forest area of the country because it is probable that the total area devoted to agriculture cannot be further reduced. In fact, it is estimated that the needs of the population may by 1950 require a larger agricultural area unless technological developments continue to increase the efficiency of production. The additional 25 to 30 million acres of submarginal agricultural land likely to be in need of some degree of reforestation by 1950 will be offset, at least in part, by further clearing of forest land, particularly in the Mississippi Delta and in the West.

Abandonment of agricultural land is the result of both physical and economic causes. Loss of fertile top soil through erosion is perhaps the most important of the physical factors; others include exhaustion of soil fertility by continued unscientific cropping, rough topography, unsatisfactory climate, and the gradual encroachment of brush.

Of the economic factors, changes in the character of agriculture itself have perhaps been the most important in recent years. The decline in the use of horses and mules, which makes unnecessary the use of land in the production of feed for these animals, has been of tremendous importance. In the last few decades there has also been a marked increase in the efficiency of agricultural production which has tended to reduce the area required. The growing use of machinery in agriculture has been another important factor. It has lowered costs on the level lands and forced out of production rougher lands where farms are usually broken up into small units. These things have followed the opening of the fertile level lands of the West, which gave the initial impetus to abandonment in the East. There has also been inolved, up to the last 3 years, an attraction of farm population to the cities. Finally, agricultural land has sometimes been forced out of production by a loss of markets, resulting from the passing of local industries. In the Lake States especially, the decline of the lumber industry has caused the abandonment of considerable areas formerly employed in supplying a local market with agricultural products.

The principal factor which may lead to a permanent shift of land from forest to agriculture is an increase of population. In many localities, land-colonization schemes have been important factors in extending agricultural areas on cut-over forest land and such projects may be expected to have continued local influence.

ANTICIPATED SHIFTS IN FOREST LAND USE AND OWNERSHIP

The ownership of the present forest area as estimated in a much earlier section, Forest Land, the Basic Resource, and the anticipated shift in ownership as estimated in the succeeding section, The Probable Future Distribution of Forest Land Ownership are shown in table 1. The major shifts indicated are a substantial reduction in privately owned land and a corresponding increase in public ownership. Adjustments in use which will be accomplished as a result of these shifts in ownership involve a considerable increase in the areas reserved from commercial timber production in order to provide adequately for watershed protection and for the increasing demand for special recreational areas. But the productive use of large areas now idle will be by far the most important result of the indicated gain in public ownership. The reasons for these changes, discussed in detail in other sections of this report, may be summarized as follows:

1. The instability of private ownership in the United States is so great that in some regions it can be properly characterized as a

breakdown. It is evidenced by tens of millions of acres of tax-reverted lands, by millions more of acres which are in long-term delinquency, by a frequent shifting of ownership through tax sale and mortgage foreclosures, by gift to the public of large areas of cut-over land, and by sales and offers of great tracts at merely nominal prices.

TABLE 1.—*Estimated present and possible future ownership of forest land*

Owner	Present distribution	Possible future distribution
	Acres	*Acres*
Private:		
Farm woodland	150,000,000	110,000,000
Industrial	294,400,000	165,900,000
County and municipal	1,400,000	106,800,000
State	16,100,000	
Federal:		
National forests	107,800,000	254,900,000
Public domain	23,500,000	10,300,000
Other	21,400,000	21,400,000
Total	614,600,000	669,300,000

No figures on tax reverted lands are available for the whole country, but in the three Lake States they amount to about 10 million acres; in the Pacific Northwestern States of Idaho, Washington, and Oregon to 3 million acres; and in eight Southern States to nearly 10 million acres. In addition there are millions of acres of cut-over forest lands in various stages of delinquency which have not yet reverted to public ownership.

The acreage of land with long-term delinquency and of lands that are actually reverting to public ownership is increasing. The process has been going on for years. The situation points to the conclusion that there is a maladjustment of forest ownership—an unwise division between public and private ownership. (See section entitled "The Breakdown of Private Forest Land Ownership.")

2. The abandonment of agricultural lands creates many difficult social and economic problems. Bringing the lands already abandoned into productive condition through forestry is a problem the solution of which will depend in large measure upon public ownership. As agricultural abandonment reaches an advanced stage in any locality it becomes increasingly difficult to maintain the local government and ordinary social services. Costs of maintaining roads and schools rise out of all proportion to the number of people benefited; churches are abandoned and the standard of living may become fully as low as in city slums. (See the section "Agricultural Land Available for Forestry.") Public acquisition of land in submarginal communities in advance of actual abandonment is the logical solution of these problems. New York is the only State which has thus far recognized the public responsibility in this situation by comprehensive action.

3. The great areas of devastated and deteriorated forest land should be reclaimed. Fire and cutting supplemented by grazing and insects have made 63 million acres of timberland nonproductive of valuable timber crops. A certain portion of this vast area of unproductive land, long ago devastated, is gradually coming back to forest each year, but this gain may be more than balanced by current

devastation of some 850,000 acres annually. The natural reforestation of this devastated land is very slow, and meanwhile millions of acres lie unproductive for decades. In addition to the devastated area, 36 million acres are annually subject to deteriorating effects because of elimination of the better species from the stands through unwise cutting and fire. Fires alone, in the period 1926–30, burned annually an average of 41½ million acres, causing great deterioration and devastation. Of the total 495 million acres of commercial forest area, some 275 million acres, cut over one or more times, are producing at only a fraction of their normal capacity. (See section entitled "Current Forest Devastation and Deterioration.") Reclamation of any large portion of these lands under private ownership seems remote.

4. The small area of private holdings being maintained in a productive state is wholly inadequate. The capital, prerequisite of any successful business operation and in the forest represented by the growing stock, has been almost completely removed from about 40 percent of the privately owned forest areas and seriously reduced in amount on fully half of the remainder. The cordwood and sawtimber commercial holdings, on which an effort is being made to grow timber commercially, compose less than one fifth of the total, and organized sustained yield management is being attempted on less than 1 percent or 2.3 million acres of commercial forest holdings. (See section entitled "Status and Opportunities of Private Forestry.") Building up the growing stock to maintain adequate growth for national needs will also call for leadership under public ownership on a large scale.

5. A vast area of forest land at present is inadequately protected from fire. Although fire control on forest lands has made progress from year to year, only 54 percent of the total forest area of the United States needing protection is now under organized fire control, in spite of the fact that public aid is given many private owners to the extent that 26.5 percent of the cost is paid by the Federal Government, 55.1 percent by the States, and 18.4 percent by the private owners. There still remain 191 million acres of forest land in private ownership on which no organized fire control is in effect. (See section entitled "Federal Financial and Other Direct Aid to States.") Public action is needed to assure effective protection. In many instances public interests will be best served by accomplishing this through public ownership.

6. Of the 615 million acres of forest land in the United States, some 449 million acres have major or moderate influence on watershed conditions. The public welfare requires a type of management on these lands which will maintain a satisfactory forest and vegetative cover. The measures necessary to make these lands fulfill their function in the regulation of stream flow and in the prevention of erosion are (1) adequate fire control (2) conservative management of the resources (3) special measures for erosion control (4) effective public education, and (5) research.

The type of management required, in many instances, will cost money which the private owner cannot afford to spend since he may reap no direct benefit. In order to meet this situation public acquisition of an estimated 133.4 million acres now forested and of 21.8 million acres now classified as agricultural but submarginal for such use is desirable. (See sections entitled "Program Necessary to Meet Watershed Requirements" and "The Probable Future Distribution of Forest Land Ownership.")

7. One of the major adjustments in land use previously indicated is the anticipated large increase in areas devoted to recreational or educational purposes. It is obvious that most of the 45 million acres suggested for such use should be in public ownership. This will therefore be an important factor in future shifts between private and public agencies.

THE NEED FOR IMMEDIATE ACTION

Under the free play of economic forces, land tends to be put to the use under which it can be given the highest capital value. In the early stages of settlement of any country or region, land is in general readily available for all purposes and practically no capital value exists for the land itself. The development of communities with increasing demands for food and materials for construction soon creates competition for the use of land and this in turn establishes definite capital values. In such competition, value will be attached to land according to the income which may be derived from its use.

Land to be used for cities, towns, or special uses such as power sites, will ordinarily have the highest income-producing capacity and therefore the highest value. Land for the production of crops will rank next in value. Only the lands not suited for these uses or not needed for them will remain in forest or open range. Within each broad category the specific use to which the land is put will also depend on its relative income-producing capacity. Land may pass from one use to another higher in the scale in a series of successive stages, with the margin of each utilization class extending further out into poorer or more remote areas as development proceeds. But frequently land of the poorest intrinsic productive capacity may be capitalized at high values for real estate because of its location and so may pass directly from its original wild condition to the highest industrial use.

Values established in this process tend to rise steadily with increase in population as long as the resources of the land hold out, unless affected by factors outside the region or country concerned. Reversal of the upward trend of values for land in any category may result from opening up of new territory under conditions where yields are high and costs of production low, from the development of cheap transportation from another region previously inaccessible, from major technological changes such as substitution of the gasoline engine for animal power, or from the exhaustion of the resources which have supported the local development without the establishment of new economic services for the communities concerned. In short, any factor which reduces the income which the land may produce will serve to depress its value and may mean reversion to a lower form of use.

Within the past few decades this country has simultaneously encountered in one region or another almost all these factors tending to unsettle land values and economic use. Readjustment under the free play of economic forces is an exceedingly slow process. It has resulted in some incongruous situations and the creation of conditions which are often contrary to the best welfare of the people. It would probably be necessary for conditions to get much worse before constructive measures were undertaken on a large scale by private owners.

Without public aid, and even with it, remedial measures would be slow of application. Some measure of long-range planning and social control is essential to stimulate prompt adjustment to provide effective coordination of the various uses of land and to insure conservation of the intangible values which are as important to society as the material values.

The need for such planning is especially urgent in the present situation because the prospects of developing new regions are small, population has spread over most of the productive area, the original forest resources of the older regions have been largely dissipated, and the agricultural resource has suffered from unwise management in many regions. Failure to act wisely now in providing for the future may result in much unnecessary human hardship and may create conditions fraught with danger for the entire social and economic structure.

LAND CLASSIFICATION

Land classification surveys have been proposed and are becoming accepted as the basis for the best fundamental land-use adjustment. Their objective is systematic land-use planning based upon intensive physical, economic, and social studies of individual regions. They are an attempt, in a systematic way and after intensive study of factors affecting land use and occupancy, to assign each area to that use to which it is best adapted physically, economically, and socially. They are an attempt to bring order out of chaos in the use of lands and to substitute systems based on scientific facts for the hit-and-miss methods of the past. As such, it is hoped that they will avoid many of the pitfalls of a "laissez-faire" system with its attendant mistakes, its financial losses, and its human misery.

As the first step to systematic land-use planning, physical classification of lands is necessary since without a physical inventory of available lands and classification by possible uses there is no basis upon which to plan. Physical characteristics alone, however, do not determine the best economic use to be made of particular parcels of land or even of large blocks of land or of whole regions. It is necessary also to consider the economic and social aspects of land occupancy and use. Studies of these phases of land use become very complex and they can be made only after the collection of suitable data. Not alone must such studies consider the profitable employment of land for particular uses under present and future economic conditions, but they must consider also social environment and public welfare.

In dealing with the classification of land for agricultural use, for example, it is necessary to consider whether the situation in any locality is such as to make the community successful. The probable returns from the land must be balanced against the costs of maintaining schools, roads, and other phases of local government, as well as the feasibility of maintaining churches and other aspects of community life. Classification may prevent many unwise development schemes and point the way to substantial economies in local government.

Land classification surveys should indicate with considerable assurance which areas should be under public ownership and should make possible the allocation of units for acquisition by State and Federal agencies. But there are many difficult and perplexing problems to be solved before land-use planning based upon classification can be put into effect. There are problems of tax delinquency, tax assessments, fluctuating future prices and costs, individual efficiency, changes in agricultural and forestry methods and practices, transportation, future markets, and many others.

A large amount of work has been done and is in progress by many public agencies along the lines of physical classification of lands. Topographic, soil, forest, and other surveys covering large portions of the country have been made by Federal and State organizations as well as climatological and ecological studies. In general, a great deal of information exists concerning this phase of classification. Many economic and social studies have also been made, but because of the complexity of this phase of classification much additional information is necessary, and there is the large job of coordination and correlation to make the land-use plans.

Great impetus was given to land classification and land-use planning as a national undertaking by a conference on land utilization at Chicago in November 1931, called by the Secretary of Agriculture in conjunction with the Association of Land Grant Colleges and Universities. This conference, among other things, provided for the establishment of two national committees charged with the duty of working out the details of a national program of land utilization. It was provided that the membership of the National Land-Use Planning Committee should consist of a designated number of representatives from each of the several departments of the Federal Government that are concerned with land utilization, together with five representatives of the Association of Land Grant Colleges and Universities chosen from the various sections of the country. The membership of the National Advisory and Legislative Committee on Land Use was specified in terms of a designated number of representatives from each of 12 nongovernmental national organizations interested in land utilization and agricultural policies.

Under the leadership of the Bureau of Agricultural Economics the National Land-Use Planning Committee has been active through technical subcommittees in bringing the necessity for land-use planning to public attention, in defining objectives, in developing methods of procedure, and in general by laying the ground work for broad classification of lands and systematic land-use planning. Owing to this committee's work, land classification is becoming recognized as a large and urgent national enterprise which should be started and pushed to completion as fast and as systematically as conditions permit.

Classification must be by definite political or other units and its progress is dependent upon Federal, State, and possibly other cooperative efforts. Necessarily it will be done in widely scattered, irregular, and often small units with delayed action in some regions because of lack of appropriations and lack of readiness or ability of the cooperating agencies. Furthermore, while physical classification of lands is more or less permanent, this is not true of economic classification in view of the constantly fluctuating basic economic conditions that determine the form of land use. Economic classifications must therefore be elastic and subject to modification as conditions change, and it should be undertaken only when it is to form the basis for early public action in the formation and execution of land-use programs.

MEANS AVAILABLE FOR EFFECTING IMMEDIATE ADJUSTMENTS

The job of land-use planning based upon classification surveys is, as has been shown above, an exceedingly difficult one. At best it will take many years to classify the lands of the country and to put systematic land-use planning into effect. In the meantime, it will be possible to proceed with desirable adjustments in land use and ownership where there is no doubt as to the proper classification or where local surveys have been made.

There are large areas such as rough, mountainous watersheds that obviously have no agricultural value and where lands are of value only for watershed protection and timber production. The classification of many such areas would be simple and could be readily made at any time. Delay in starting to make such adjustments until results of a general classification are available is therefore neither desirable nor necessary. Immediate ameliorative measures are at hand and may be applied without danger of serious error due to insufficiency of facts. They are:

PUBLIC DOMAIN ADJUSTMENTS

As of June 30, 1932, the public domain contained 173,318,246 acres located largely in the western part of the United States. As the remnant of the original large Government holdings, it is, of course, the poorest part, and it remains without any form of management or administration. Most of it is treeless, semiarid land and of little use for anything except grazing. A total of about 22 million acres of the public domain should be added to the national forests. The remainder should be organized into administrative units in order to conserve the grazing resource and prevent erosion. Legislation which will effectually accomplish this purpose should be enacted. (See section entitled, "Public Domain and Other Federal Forest Land.")

FEDERAL ACQUISITION BY PURCHASE

Western national forests were created from the public domain, but at the time when the national-forest movement started, little public domain was left east of the Great Plains. Small areas, however, were set aside as national forests in Wisconsin, Michigan, Arkansas, Alabama, and Florida. The participation of the Federal Government through national forests in the eastern forestry movement can, however, be said to have started in 1911 with the passage of the Weeks law (act of March 1, 1911, 36 Stat. 961), which authorized the purchase of forest lands by the Government on the watersheds of navigable streams. Supplementing this, the Clarke-McNary law (act of June 7, 1924, 43 Stat. 653) extended authority to purchase lands for timber production. Under these laws the Federal Government has acquired in 19 States in the East, up to June 30 1932, a total of 4,727,680 acres of forest lands which have been incorporated into national forests. The total national-forest area in the eastern half of the United States has through acquisition been brought to 7,217,731[1] acres as of June 30, 1932. The program under which the Forest Service is now working in acquiring lands in the eastern United States contemplates an eastern national-forest ownership of somewhat more than 14½ million acres.

---

[1] Exclusive of 13,824 acres in Puerto Rico.

Purchases are made within units established for that purpose only after approval by the National Forest Reservation Commission as is described in detail in the section entitled "Public Acquisition of Private Lands as an Aid to Private Forestry." As lands are acquired, they are incorporated in the national-forest system, placed under protection, and rehabilitation begins.

The methods and procedure used in Federal-purchase work constitute, in effect, a system of land classification, since the selection of a unit is made only after the survey of a much larger area and consideration of the needs and desirability of a national forest in the forest region concerned. A unit is established only after it has been determined by these methods that a large part of it is true forest land which will serve the purpose of watershed protection, timber production, or forestry demonstration. Agricultural lands within established units are segregated and not acquired.

Through the years, Federal officers have gained considerable experience in purchasing forest lands. Methods have been thoroughly developed and standardized so that increased purchase activity could be expeditiously handled by the experienced organization which already exists. In the past, lands have been purchased at reasonable prices, and under present market conditions large blocks of additional lands could be obtained upon decidedly favorable terms. Much of the 134 million acres programmed for national forest ownership could therefore be purchased and developed by the Federal Government without awaiting general land classification, provided funds became available. A greatly increased acquisition program by the Federal Government would be one of the most constructive adjustments which could be undertaken.

Two other Federal agencies are acquiring forest lands in the East. The Biological Survey has inaugurated a purchase program which contemplates acquisition of about 500,000 acres for game sanctuaries and wild-fowl breeding grounds. So far it has acquired 254,000 acres, of which perhaps 60,000 acres are water. The National Park Service is obtaining 587,000 acres for two national parks in the Appalachians by gifts from the States of North Carolina, Tennessee, and Virginia which are purchasing the lands and conveying them to the United States. Because of the comparatively small size of these acquisitions they will have little effect upon the general problem of forest land use in the East.

STATE ACQUISITION BY PURCHASE

State, county, and municipal ownership of present commercial forest areas consists of 10,632,000 acres, most of it obtained through Federal grants but some through purchase or tax delinquency. Except in New York and Pennsylvania, however, little progress has been made in State acquisition of forest lands through purchase. Most of the States in forest regions have been unable to finance large purchase programs up to the present time. The urgency of the situation, however, as well as the necessity for the various States to carry their full share of the responsibility for future forest conditions dictate the advisability of State and local public acquisition programs of 89 to 90 million acres, some of which will come through tax delinquency rather than purchase. In prosecuting plans of this kind and in making selections for State forests, surveys for land classification will, of course, be necessary.

TAX DELINQUENCY

Other sections of this report have shown that tens of millions of acres of cut-over forest and submarginal agricultural lands are long term tax delinquent or have actually reverted to counties and States through failure of sales of tax-delinquent lands. Most of the forest lands have been cut over and repeatedly burned. Private ownership can see in them only heavy expense in carrying charges with no opportunity for income for many years in the future. It has lost interest in them, and they are lying there unmanaged and further deteriorating.

A few States have enacted laws under which tax-delinquent lands may become State, county, or town forests, but in general it has been local public policy to return such lands to the tax rolls through sales or otherwise. The rapidly growing acreage of these tax-reverted lands shows that this policy is not suited to the handling of forest lands.

Within their financial ability, it would be a constructive adjustment in land use if local political units in States in which they get title to such forest lands would retain ownership, consolidate the lands where necessary, and manage them as community forests. It is recognized, however, that local political units would not be able to absorb large areas of such lands.

Most of the devastated forest lands which have become or are becoming tax delinquent will stay in public ownership whether they are wanted or not. Some form of public management must therefore be devised unless these lands are to be permanently nonproductive. Where local political units come into possession of them and cannot or will not manage them, consideration should be given to the possibility of their transfer to States for State forests, or as a last resort to the Federal Government as national forests. Primarily, the problem of tax-reverted lands is one of determining the form of public ownership. Responsibility for the proper administration of these lands is divided between local political units, the States, and the Federal Government. The necessity is for careful consideration, based largely on surveys, as to which unit should manage them; and as far as possible it is desirable that they be managed by local units or States. On the other hand, when these units are unable to assume this responsibility, when they desire to convey such land to the Federal Government, and the lands fall logically into the national forest system, the United States should stand ready to accept them. Under such a policy large areas of forest lands which private owners do not desire and cannot afford to hold would become publicly managed forests instead of remaining a "no-man's land" rapidly degenerating into absolute waste.

EXCHANGES

Federal purchases have not as yet been extended to the West, where national forests already contain 53 per cent of the commercial forest-land area. Authority has, however, been obtained through legislation to exchange national-forest lands or timber for private lands, and under these laws the western national forests are being consolidated and somewhat extended. Increases in the net area of the western national forests through such exchanges has so far amounted to 814,685 acres. Under exchange procedure, many areas of cut-over land on which forest values will be either protected or restored, are coming into Federal ownership and at the same time national-forest properties are being consolidated.

Opportunities for consolidating the western national forests through exchange are limited both because private owners as a rule are not interested in exchanging their lands for other forest lands and because the quantity of national-forest timber available to exchange for cut-over lands is limited. While considerable additional progress can be made toward the consolidation of these Federal properties through exchanges, they cannot be relied upon for the complete consolidation of forest lands in the western national forests.

Exchanges are of value primarily in consolidating and building up feasible administrative units where intermingled holdings of several ownerships exist. Their possibilities have not been generally recognized, but in any large scale adjustment of ownership of forest land they can be applied extensively. In many regions they are the most feasible methods by which solid blocks of single ownerships may be built up for efficient and economical forest management. Extensive possibilities exist for exchanges between the following agencies:

1. The Federal Government and private owners, to allow each to build up solid blocks of forest or to permit the consolidation of national-forest lands at the expense of Federal timber and at a saving of Federal appropriations, or through the exchange of Federal lands of higher value for agriculture than for timber production.
2. The Federal Government and States, to allow each to consolidate holdings for public forests.
3. The States and private owners, to accomplish the same purpose as stated for Federal exchanges.
4. Private owners for mutual consolidation of holdings.

No definite program of exchanges can be set down at this time. As public acquisition proceeds, either through purchase or tax delinquency, it is safe to predict that exchanges will play an important part in consolidations and that many million acres will change ownership by this method.

GIFTS

In recent years, some gifts of land have been made to public agencies by private owners. Gifts of forest lands to be incorporated into public forests, whether to Federal, State, or local governments, should be encouraged. Through such gifts of land and timber, land with timber reserved, or of cut-over land, conservative management and effective protection of the areas involved are assured. Gifts of land to public agencies are preferable to tax delinquency with no intention of redemption.

ADJUSTMENTS BY PRIVATE OWNERS

Adjustments in land use are taking place and will continue in connection with the practice of forestry by private owners. There will be shifts in ownership through purchase and exchange to build up feasible administrative units, to consolidate holdings already acquired, and to round out farm units.

Some areas of forest lands are now managed under private ownership primarily for the development of resources other than timber. In this class come lands held by water power companies, recreation lands, and lands held as game preserves. In general, such lands are efficiently protected against fire and are well managed. In addition, coal and mining companies own estensive timberlands, sometimes for their underlying minerals and at times for a timber supply. Management of such lands varies from good to practically none at all.

In general, lands held for these special purposes are a small part of the total forest area. It is not likely that the area of such lands will increase rapidly, and because of their comparatively small extent they will have little influence upon proper land use. For the most part, it may be said that they are being put to a high use.

CONCLUSION

Land classification, taking into account physical, economic, and social factors and having as its objective comprehensive land-use plans, is the most constructive proposal yet made for bringing about the highest use of land in the United States.

Without waiting for the results of general land classification, however, many adjustments of advantage to both agriculture and forestry can be made by local surveys leading to the acquisition and management of obviously true forest lands by Federal, State, and local political agencies either through purchase, tax delinquency, exchanges, or gifts, and through purchases and exchanges by private owners who desire to practice forestry. Of these measures, the acquisition of forest lands as well as the retention and management of tax-reverted forest lands by States and a largely increased program of Federal purchase are the most important. They will, faster than any other measures, take submarginal land out of agricultural use, make possible adequate provision for public recreation and watershed protection, and build up a system of well managed forests from the large existing area of cut-over lands the deterioration of which under private ownership involves tremendous losses in publlc welfare.

THE PROBABLE FUTURE DISTRIBUTION OF FOREST LAND OWNERSHIP

By S. B. Show, Regional Forester, California National Forest Region [1]

CONTENTS

	Page
Stability of ownership prerequisite to forestry	1253
The basis for private ownership of forest lands	1256
The basis for public ownership	1256
The basis for division of public ownership between agencies	1261
Progress to date in public forest acquisition and existing programs	1263
How much forest land will private owners retain and use in accordance with public interest?	1265
Public ownership and timber production	1278
Public ownership and watershed protection	1286
The multiple-use forest program recommended for public ownership	1294
The probable distribution of forest-land ownership between public agencies	1296
The cost of the public-acquisition program	1299
A suggested immediate Federal and State program	1300
Summary	1301

STABILITY OF OWNERSHIP PREREQUISITE TO FORESTRY

Stability of ownership of forest lands is a prerequisite to the stability of forestry. The bulk of the commercial forest lands are now in private ownership, but significant changes in ownership are taking place with great rapidity, and on a Nation-wide scale. Extensive tax delinquency in the cut-over regions; failure of any considerable number of owners to take advantage of the special forest tax laws enacted by many States specifically to help the private owner remain in the forest-land business; the rapid exploitation of forests with scanty provision by the owners for continuing in the forest-growing business; and the very large areas of forest land offered at distress sale to public agencies—all are indicative of existing changes in forest-land ownership. These trends are even more significant as symptoms of widespread and imminent changes in the distribution of ownership.

Formerly forested land, now or recently used for farming, is being abandoned as unsuitable physically or economically for farming, and is thereby becoming available again for forest production. Major changes in the character of ownership of such land are obviously inevitable if it is to be managed for its highest value of forestry.

Other sections of this report bring new information to bear on the forest situation and the forest problems of the Nation. To a very high degree, these finally focus on the question of ownership—whether existing ownership is accomplishing the full conservation of forest values so clearly needed, whether it is likely to, and whether a realinement of ownership should be deliberately sought, regardless of the trend toward breakdown of private ownership, and the consequent shift toward public ownership. Other sections of this report in fact suggest or recommend increase in public ownership as a means to accomplish such purposes as watershed protection, balancing the timber budget, and conservation of recreation and wild life values.

---

[1] The subsection Estimated Public Share of Land Ownership for Timber Production is largely the work of E. I. Kotok, Director, California Forest Experiment Station. The tabulation of census records used in estimating areas feasible for public ownership in the subsection, Limiting Factors in Establishing Public Protection Forests was worked out by W. N. Sparhawk, Senior Forest Economist.

Public acquisition programs by some of the States and by the Federal Government are already established, but with the exception of a few outstanding States such as New York, Pennsylvania, and Michigan they are going ahead slowly. These public programs with few exceptions were based on what today appears to be an underestimate of the public values of forest lands, or on an overstimate of the stability of private ownership and management, and of the degree to which private ownership conserves them.

Clearly, a fresh appraisal of the probable distribution of forest land ownership is needed, one that takes account both of what is likely to happen anyway as a result of the breakdown in private ownership, and of what should be done in the direction of public ownership to meet the known needs of the forest situation. Such an analysis, which this section of the report attempts, is beset by many difficulties. Major trends, involving hundreds of millions of acres of land, varying economic conditions, deeply planted habits of political and economic thought and tradition, and complex interrelation and conflict between public and private needs and values, are not to be resolved into formulae accurate to the last decimal point. Estimates and approximations have necessarily been used in analyzing the problem, and great accuracy in the conclusions cannot be claimed. But even rather wide approximations, and the differing results obtained from various approaches to the problem, emphasize rather than obscure the conclusion that very large shifts from private to public ownership are both inevitable and necessary.

The present distribution of forest-land ownership, summarized in table 1, focuses attention on several major questions that are necessarily involved in any appraisal of future distribution of forest-land ownership. At the start, it is necessary to consider what are the bases for private and public ownership.

TABLE 1.—*Present distribution of forest land ownership*

[In thousands of acres]

Forest region	Commercial forest area							Chiefly valuable for other purposes than timber	Total forest area	Agricultural land available
	Private			Public			Total			
	Woodland on farms	Industrial	All private	Federal	State and other public	All public				
New England	6, 402	19, 576	25, 978	471	824	1, 295	27, 273	161	27, 434	3, 736
Middle Atlantic	9, 461	15, 470	24, 931	347	1, 861	2, 208	27, 139	2, 631	29, 770	8, 861
Lake	14, 281	34, 792	49, 073	2, 955	3, 867	6, 822	55, 895	4, 450	60, 345	6, 012
Central	32, 158	31, 319	63, 477	581	191	772	64, 249	1, 810	66, 059	14, 345
South	57, 866	129, 398	187, 264	3, 213	281	3, 494	190, 758	26, 110	216, 868	18, 750
Eastern regions			350, 723			14, 591	365, 314			51, 704
Pacific Coast	5, 099	27, 938	33, 037	31, 811	1, 837	33, 648	66, 685	14, 610	81, 295	
North Rocky Mountain	1, 413	5, 925	7, 338	23, 725	1, 266	24, 991	32, 329	10, 858	43, 187	
South Rocky Mountain	43	5, 098	5, 141	24, 924	505	25, 429	30, 570	59, 030	89, 600	
Western regions			45, 516			84, 068	129, 584			
Grand total	126, 723	269, 516	396, 239	88, 027	10, 632	98, 659	494, 898	119, 660	614, 558	51, 704

THE BASIS FOR PRIVATE OWNERSHIP OF FOREST LANDS

The bulk of the commercial forest-land acreage is in private ownership. The 127 million acres on farms are held by a multitude of individuals, in the vast majority of cases, as a mere incident to the primary purpose of maintaining a farm.

The 270 million acres of private commercial forest land owned by other than farmers were for the most part acquired by lumbermen and others whose sole concern was to obtain title to virgin stumpage which could quickly be exploited and turned into cash, either by operating it themselves or by selling it to others. This was one of the traditional means of acquiring a fortune, and in the vast majority of cases, the individual had little interest in the land, except to convert virgin timber into cash. In this process, it was to be expected that forests would ultimately be converted into vast areas of denuded and poorly and partly stocked cut-over land which has accumulated at an ever increasing pace.

The existing extent and geographical distribution of forest land in private ownership is a result of the liberal land disposal laws and policies on the part of the Nation and the States and the desire of individuals to enter what appeared the very profitable business of lumbering and timber exploitation. The land was acquired for the disposal of the standing timber, with no regard for future timber crops under any form of forest management.

In the pioneer period a particular tract of timber passed into private ownership when some individual thought he saw a chance to make money out of it. Now a particular tract of cut-over land from which the exploitable timber values have been removed remains in private ownership only when some individual sees in it a chance to make money either from growing timber or from the production of some other salable crop.

Public policy was never able to force into private ownership large areas of low grade or inaccessible timberland. Public policy through liberal laws could and did make it easy to acquire timberland. Public policy can make it easier for the owner to hold his land, through various forms of public aid. But no public action can force forest lands now in private ownership to remain in that status.

A statistical tabulation of existing distribution of ownership by States, regions, or the Nation is merely a current record and has only slight evidential value in forecasting future distribution. Even the most superficial survey of trends discloses, however, the large acreage of tax-reverted or tax-delinquent land, and the large acreage of virgin stumpage and cut-over land now offered for distress sale, and proves that large numbers of owners have decided or are deciding that continued ownership is a losing game.

THE BASIS FOR PUBLIC OWNERSHIP

As indicated by table 1, publicly owned commercial forest lands are widely distributed geographically and make up 20 percent of the total commercial forest area. The continuing land acquisition programs of the Federal Government and of many States and local governments indicate widespread belief that public ownership of at least certain forest lands is preferable or supplemental to private ownership. What is the basis for public ownership?

LEGAL BASIS

The legal basis for forest land ownership is established in many States and for the Federal Government. As to the latter, the basic laws of 1891 and 1897 establishing the national-forest system, the Weeks law of 1911, and the Clarke-McNary law of 1924, all set up the purposes of timber conservation and production, watershed protection, and the protection of navigable or interstate streams, harbors, and Federal power or irrigation projects as justifying Federal forests. The laws establishing the national parks make forest recreation a purpose of Federal reservations.

In the States with acquisition programs, watershed protection, timber production, forest recreation, and wild-life conservation are variously recognized as justifying State ownership.

The forest land acquisition by the Federal Government is limited by the legal provision that advance legislative authorization must be granted by each State before any Federal program can begin. Under existing Federal law this power of a State to prevent Federal acquisition, or to limit the area acquired, is not restricted.

ECONOMIC BASIS

In the West the national forests included originally those public lands which had been unattractive to private ownership. Elsewhere—and the same is true with regard to acquisition of private lands for the western national forests—all forms of public acquisition of forest lands are to be justified by the fact that the lands possess values of public importance, protection, recreation, and wild life, which can be or are depreciated or jeopardized by the practices of private ownership. Also, the private owner, being almost universally under compulsion to handle his property for profit, commonly destroys or reduces the timber-producing value of the lands, thereby injuring the public interest in a continuous and abundant supply of forest products. Other sections of this report detail the degree to which unrestricted private ownership has done this.

To protect its inherent interest in the maintenance of all values on privately owned forest lands the public may do several things:

(1) Trust to the free play of private initiative.

(2) Subsidize or assist the owner, in the expectation that his treatment of the forest land will improve.

(3) Regulate the owner's use of his property, either with or without the assumption of part or all of the additional management costs thereby made necessary.

(4) Undertake ownership of the land, thereby receiving the income from ownership as well as incurring the expense.

These alternatives are usually designated as policies of (1) "laissez-faire", (2) public aid, (3) public regulation, (4) public ownership.

The traditional attitude toward forest land was that of "laissez faire"—the classic idea of economics that since it is to the owner's advantage to keep his property productive he will automatically do so. This treatment of the forest land arose naturally from the fact that originally the major problem of the Nation, as the primary owner of the forest lands of the country, was to get a major share of these apparently inexhaustible lands into private ownership as quickly and simply as possible, as the basis for settlement of new territory and for the rapid economic development of the country. In this process the liberal land disposal laws and the generous grants of forest lands to States, institutions, and railroads played an important part. So, too, did the traditional "cut-out-and-get-out" practice of timber mining. For the first century and more of its existence the Nation could well accept the heavy wastage of forest resources and the wholesale loss of public lands, which early became an integral part of the rush and sweep of the pioneer period and typified its spirit. Ownership of forest land carried no obligation expressed or implied.

But toward the end of the last century the need for national concern in forest lands became an urgent public issue. The last frontier was reached; the inexhaustibility myth was exploded; and the cumulative effects of land mistreatment, resource wastage, and giving away of public forest lands could no longer be overlooked by the people of the Nation and by the National Government. The first major expression of a newly aroused concern appeared in the creation of the national-forest system, designed from the beginning to retain and manage under the principles of forestry the forest lands remaining in national ownership. In addition thus to restraining somewhat the further aggravation of the Nation's forest problem it was hoped that the examples of technical forest management would stimulate similar ventures by the States and private owners on their forest properties. The venture marked the end of complete faith in the working out of the laissez-faire idea.

In 1911 the Nation extended its program of national-forest establishment to include the purchase of private forest lands located on headwaters of streams in the East. The need for Federal control of natural resources through ownership and management of forest lands was thus early recognized. Along with this development of the national-forest system went the development of State forests in several of the States, some antedating the national-forest system, others stimulated by the example set by the Federal Government.

The inauguration of Federal aid in fire control in 1911 was a recognition that there was a national interest in all forest lands, that private ownership needed assistance, and that the forests would remain largely in private hands. It greatly accelerated the attempt to solve the forest problem through the second method of public action—that of public aid. In line with this broader concept of public obligation most of the forest States developed public aid in fire control as an assistance to private owners. The degree of aid given from State funds varies widely, but there has been very general recognition of State interest in the treatment and condition of private forest lands.

To date the Federal Government has functioned in forest affairs in two principal directions:

First, by supplementing through public aid the State and private efforts, but leaving primary responsibility in their hands, to the degree necessary to do the job right, and where there is real intent and effort by State and private owners to do the job. Second, when other agencies were unable to unwilling to manage private forest land, by acquiring and managing it as a national enterprise. In this twofold program there is no abandonment of the Nation's traditional desire that State and private effort handle the forest problem to the greatest practicable degree. Many of the States have followed substantially the same course—giving public aid to private owners and at the same time acquiring State forests.

But in another respect State policies have gone beyond the Federal forest policy in the attempt to solve the forest problem. In many States laws have been passed regulating the use of private forest lands in various particulars. This departure has, however, been hardly more than tentative. In no State are there complete laws designed to insure good condition of forest lands, and many existing laws are not enforced. The Federal Government had made no effort to regulate the use of private forest land. After careful study of this method, it has thus far elected to expand Federal aid instead. Public regulation has thus been applied to only a limited degree in this country, although other nations use it widely.

During this period of trying out alternative methods, opposition to public ownership has more and more centered on the idea that private ownership of forest land was essential because through taxation it supplied the revenues for local government. Private ownership is not, however, the only way in which local government may draw on forest land for current income. Two plans have been worked out to make publicly owned forest land contribute its fair share. The most widely applied of these is the national-forest plan under which 25 percent of the gross income is returned to the counties from which it was derived, in lieu of taxes.

Under the other plan, on some of the State forests, notably in Pennsylvania, a flat rate per acre per year is returned to the county.

The public ownership method has thus been adopted very widely because the other methods have been found to fail in guaranteeing permanently acceptable condition of forest lands. Public ownership of forest lands is then often a last resort device to protect public interests from damages resulting from abuse by private owners.

PUBLIC OWNERSHIP AS COMPLEMENTARY TO PRIVATE OWNERSHIP

Public forests have been established and managed under appropriate legal sanction by Federal, State, and local governments for the following purposes:

(1) To protect watersheds from damages resulting from mistreatment by private owners. Public ownership of protection forests of high importance is commonly recognized as a necessity where the desired condition of forest land cannot be obtained under private ownership without undue friction. This may be either because of conflict between public and real or supposed private interests, or because private owners withdraw from ownership and refuse to keep the land. The watershed section of this report details areas and regions in which critical watershed problems now exist.

(2) The provision on forest lands of recreational and related facilities open to the public has become recognized as a public function, accomplished through ownership of the land. Use of forest lands for such purposes commonly cannot be harmonized with the needs of private owners. This report (see section on "The Forest for Recreation") recommends publicly owned forest recreation areas to the extent of 45 million acres, a very considerable part of which coincides with areas of high watershed importance suggested for

public acquisition. Management of forest lands for recreational use conserves the watershed values.

(3) The public interest in continued productivity of forest lands has more and more been recognized as justifying public ownership where private owners will not keep the lands reasonably productive, and where the values produced through public management are likely to equal or exceed the costs. It is shown in detail elsewhere that for the Nation as a whole, and in many of the important forest regions, the private lands are in a very unsatisfactory condition as to growing stock. The conclusion is reached that on a very large area of forest lands, the growing stock must be built up to safeguard the timber supply of the Nation. Clearly, the accomplishment of this purpose through public acquisition and management becomes necessary and is, therefore, justified only when and to the extent that private ownership fails to accomplish it. An exact appraisal at a given moment of the extent to which, and areas and regions in which, private ownership will adequately redeem the public interest in forest productivity, is beset by many difficulties and is, indeed, virtually an impossibility.

(4) A large area of wrecked, denuded, or badly depreciated forest land, often designated as "no man's land" or "the new public domain" is a special field for public ownership. Most of such lands, are permanently submarginal for private ownership, since they no longer produce current income, and eqruire capital investment, current expenditures, and a long wait for returns. Through the process of tax delinquency and abandonment, many are reverting to public ownership.

Other lands in this class drift from owner to owner, each of whom further depreciates the small values that may remain, and each in turn gives up the effort. This process is definitely antagonistic to the public interest and, so long as it continues, postpones any stability of ownership or systematic attempt to manage the lands constructively and restore their productivity. In most cases public ownership and management of such land is coming to be recognized as the ultimate and desirable solution.

(5) At least 50 million acres of formerly forested land, which has been used for agriculture, is no longer used for that purpose. Much of this is likely to require public ownership, if for no other reason than to remove it from the total of submarginal agricultural land, which is only occasionally used as it drifts from owner to owner. This threat to agriculture can be eliminated through controlled use for non-agricultural purposes in public ownership.

In the main, public ownership comes into the picture to protect public values and interest on classes of land or in regions where private ownership and practices have depreciated values, are depreciating, or are likely to depreciate them. Demonstration areas and scenic and recreational areas of particularly significant value are commonly acquired regardless of the intent or practices of private owners. Public ownership is not then generally competitive with private enterprise, but steps in when necessary to obtain results with a certainty not obtainable otherwise. Traditional political thought predominately holds that when private ownership applies the same practices to forest land that public ownership does, the former is in fact preferable. Public acquisition programs built on this clear-cut principle can be scrutinized from the standpoint of what public agency can best undertake the job, and the feasibility of providing the necessary money, but not with a question as to whether the public should go in at all.

The break-down of private ownership is forcing public ownership of forest lands on a scale previously not anticipated. In the future, involuntary public ownership appears certain to be more and more widespread and extensive regardless of deliberate public acquisition programs.

THE BASIS FOR DIVISION OF PUBLIC OWNERSHIP BETWEEN AGENCIES

HISTORICAL BACKGROUND

Ownership of forest land by the smaller political subdivisions—towns, cities, and counties—is described in detail elsewhere. The total area now owned and managed is not large (about 1 million acres) and is to a considerable extent for park or water supply rather than forest purposes. Title to the large area of land abandoned by private ownership through tax delinquency lies in the counties in many of the States, in towns in others, or in the States directly. For the most part, counties in which land abandonment is active are little able to undertake constructive management under the principles of forestry. Depreciated forest land is generally a net expense for many years and the very process of land abandonment reduces the local government's income. Thus at the time when additional expense is required to care properly for the land, local government usually is least able to undertake new jobs.

In a few States a systematic effort is under way, sponsored by the State government, to make management of forests possible for the counties, and even the towns and cities. But in the main and with relatively few exceptions, public ownership must be either by the State or Nation.

As to the division of ownership of forest land between the States and the Federal Government, the question of what is theoretically best or most desirable in terms of our history and political thought is much confused. A strong element of political theory would leave the problem to the several States. But in most of the regions where national forests have been managed longest, public opinion supports fully this Federal venture. Federal forests, even though established to meet national needs, have come to be recognized as giving important benefits to the States in which they are located.

In law, and to a large extent in public opinion, forest lands needed for the protection of navigable or otherwise important interstate streams have come to be held as a major class of land of peculiar Federal interest. But in a few States, notably New York, the State forest programs have undertaken to acquire all of the forest lands of this character for which public ownership is needed, although the primary purpose for State acquisition may be something else. In other States, as for example Pennsylvania, both State and Federal forests contain lands of similar character and equal value for watershed protection. Even though Federal ownership of important watershed areas has become reasonably well sanctioned, individual States have undertaken all or a large part of the public acquisition program for watershed protection.

Similarly, the general Federal responsibility to insure through land ownership the stability and permanence of the timber supply for the Nation as a whole is well established.

The Federal forest acquisition program has during the past 21 years gone ahead of several well-defined principles:

1. Where States have the desire, intent, and financial ability to undertake the full job of public forest acquisition, no national forests have been established, even though forest land problems are present that are well within the sphere of Federal land acquisition. No real need for national forests is recognized under such circumstances.

2. Where forest land problems exist, properly within the sphere of Federal land ownership, and where the State has the desire, intent, and financial ability to undertake a major part of the job, and is willing for the Federal Government to undertake part, national forests have been established. These joint programs have been carried out without conflict or competition.

3. Where problems exist, and the State is financially unable to undertake the public forest acquisition job, but is willing that the Nation do so, national forests have been established. Clearly, under such circumstances the Federal Government must take over the bulk of the public ownership job, if it is to be done at all.

4. Where problems exist, and the State lacks the willingness or financial ability to undertake the job, and for one reason or another is unwilling for the Federal Government to come in, no national forests have been established.

Whether or not a State embarks on a State forest program appears to depend primarily on financial ability rather than on political theory or desire. A number of the wealthier States have gone further and have more comprehensive programs than the less wealthy States. State forests starting with denuded or partly stocked lands, are necessarily a net expense for many years. Regardless of the need, the less wealthy States have been slow to start State forest programs.

In several of the Western States, such as Idaho and Oregon, the remaining portions of the Federal land grants to the States have been placed under administration as State forests.

In Michigan tax-delinquent lands have been consolidated into State forests.

DESIRABILITY OF STATE OWNERSHIP

The question of the division between State and Federal ownership of public forests has slowly crystallized as one principally of State financial ability and intent. The part falling to the Federal Government in order to protect the public interest is that part of the full job which the State is unable to do, and which it is willing to let the Federal Government undertake.

A major conclusion from experience to date is that there can be no true conflict between the State and Federal Governments in forest-land ownership when the Federal Government comes in with State sanction to handle through ownership forest lands which States are unable to manage. The very processes of forest deterioration and forest devastation are the basis alike of local impoverishment and national concern. Therefore no question of propriety or of Federal imperialism can arise, if the expansion of Federal effort in forest land management is confined to lands where national interests are paramount or where State and private efforts are factually found to have failed or to be failing. The question of form of ownership is merely one of what action will obtain the essential result, and what agency is able to carry it out.

As to the desirability of a large increase in ownership and management of forest lands by the States, there can be no doubt. The basic question between the States and the Federal Government is not one of competition in forest-land ownership, but of whether interstate or other national interest is involved and the extent to which individual States are able financially to undertake the full task on the forest lands not properly cared for in private ownership.

The problem of whether the State or the Federal Government or both should handle the additional public forest acquisition in a particular area is thus in the main a question of determinable fact and not of abstract theory. What is important, and urgently so, is that a realistic determination of each local situation be made, as a basis for effective action.

In individual States, therefore, the best division of public-forest ownership will range from predominantly State to predominantly Federal. Sometimes it may be advantageous to have State and National forests in separate parts of the State. The sole criterion of the success or failure of the public-forest program is not who does the job, but whether the full job of management of lands which private ownership does not keep in good forest production, is done.

From the standpoint of experience to date there is little basis for arguing for or against State or Federal forests as inherently superior or inferior. There are examples of able professional management of both. Continuity of policy, freedom from politics, technical per- sonnel, and adequacy of funds are the essentials in both Federal and State forestry.

That some of the States are still disposing of their forest lands and resources without the application of forestry principles no more proves the inherent incompetency of State forestry as a whole than does the fact that the United States is disposing of its public domain and railroad grant lands in the Northwest, now revested in the United States without proper care prove its inability to manage Federal forests.

PROGRESS TO DATE IN PUBLIC FOREST ACQUISITION AND EXISTING PROGRAMS

In table 2 there is summarized the area previously acquired for State forest purposes, the area being acquired, and the ultimate area to be owned when present policies and plans have had full effect. The grand totals under these three captions are 4,396,000 acres, 2,232,000 acres, and 12,770,000 acres, respectively. A few of the Northern States, notably Michigan, Minnesota, New York, Pennsylvania, and Wisconsin, account for the bulk of the acreage in all categories. A considerable number of States have small or nonexistent ownership or plans for ownership. The section on "State Accomplishments and Plans" describes in detail the State forest programs.

The New England, Middle Atlantic, and Lake groups of States now own almost 90 percent of the total area of State forests, and the 3,925,000 acres of State forests makes up but 3.5 percent of the total forest area in these regions. In the South the 45,000 acres of State forests is but 0.02 of 1 percent of the forest area.

When full effect is given to existing plans in the New England, Middle Atlantic, and Lake regions, the State forests will include about 11.3 percent of the total forest area in these regions, whereas in the southern group of States they will include not over one sixteenth of 1 per cent.

TABLE 2.—*Present and prospective area of State forests*

Region	Net area	Land being acquired	Ultimate area under present policy
New England	255, 838	4, 027	500, 000
Middle Atlantic	1, 746, 708	120, 809	4, 400, 000
Lake	1, 921, 068	2, 103, 400	7, 500, 000
Central	98, 126	3, 400	250, 000
South	45, 006		120, 000
Pacific Coast	125, 803		
North Rocky Mountain	203, 000		
Total	4, 395, 549	2, 231, 636	12, 770, 000

Less formal plans and programs, based on appraisals of what is desirable, indicate that if possible the officials of States wish to increase the eventual extent of State forests to 51,000,000 acres. This is exactly four times as much as contemplated under existing formal plans.

Table 3 summarizes the present ownership in national forests, and for the eastern States shows the additional areas in formally approved purchase units, in units known to be urgently needed but not formally established, and the total national forest area when both these plans have been carried to completion.

In the East the total area now owned is 7,218,000 acres,[1] of which 4,704,000 acres are primarily for watershed protection and 2,514,000 for timber production. The additional area planned in approved and tentative programs is 7,639,000 acres. The total ownership when these plans shall have been carried to completion will be 14,857,000 acres, or less than 5 percent of the total forest area of the East.

The present ownership in the West is 132,786,000 acres of which 68,375,000 acres are commercial forest land. This is about 52 percent of the total commercial forest area of the West. It is definitely planned to acquire about 11,000,000 acres within the forest boundaries and an additional 7,500,000 acres outside of present boundaries. The total national forest ownership in the West will then be 151,286,000 acres, compared to 14,857,000 acres in the East.

TABLE 3.—*Present and prospective area of national forests*

[In thousands of acres]

Region	Net area	To be acquired, definite plans	Total then owned
New England	566	564	1, 130
Middle Atlantic	371	235	606
Lake	1, 868	1, 932	3, 800
Central	730	1, 280	2, 010
South	3, 683	3, 628	7, 311
Pacific Coast	42, 190	18, 500	151, 286
North Rocky Mountain	35, 507		
South Rocky Mountain	[1] 55, 089		

[1] Includes Wyoming.

---

[1] Exclusive of 14,000 acres in Puerto Rico.

HOW MUCH FOREST LAND WILL PRIVATE OWNERS RETAIN AND USE IN ACCORDANCE WITH PUBLIC INTEREST?

It has already been said that the original basis for private ownership of most forest lands was the accumulated merchantable timber which could be converted into cash. The widespread breakdown of private ownership, involving many millions of acres of cut-over land, shows clearly that forest-land owners are reappraising their properties from the standpoint of their probable value for timber growing.

FACTORS INFLUENCING PERMANENT PRIVATE OWNERSHIP OF INDUSTRIAL TIMBERLAND

Each owner, if he consciously desires to hold and manage a forest property, must weigh and appraise a number of economic factors which influence profits. His motives for holding the land may be, for example, recreation, grazing, private hunting preserves, or future speculation values, but in the majority of cases he will look to timber products as the source of revenue and will measure the profitableness of ownership in terms of this commodity. Some of the more significant factors which must guide him in his decision are enumerated in the following as illustrating the complexity and variety of a forest enterprise.

COST OF PRODUCTION

A large group of factors is involved in the marketing of forest products. Whether the markets for sawn lumber and pulp are close to the forest property, as in New England, or distant, as in the northern Rockies, is important. So is the question whether markets for bulky low-value products, such as cordwood, which are harvested during the saw timber rotation, are generally close, as in the Middle Atlantic region, or distant, as in most of the Pacific region. In the South, the production of naval stores of small bulk and high value, during the rotation, is a favorable factor which many other forest regions lack. In parts of the South, too, salable by-products are obtainable from small trees at an early age, an advantage to private forestry largely absent in the western regions.

Whether regional markets are likely to absorb the future production within the region, as in the New England, Middle Atlantic, Central, and Lake States, or whether export will be necessary, as in the Pacific region, likewise affects the outlook for private forestry. The existence of roads, so that intrarotation products can readily be reached, as in several of the eastern regions, gives an advantage not found in the West.

Established markets for certain forest products, as in New England, are a great asset. In a few regions of the East, integrated forest utilization centers, absorbing all kinds of forest products, have been established, and give owners of forest lands an assurance of markets that they lack where products must go long distances to the general competitive markets. None of these highly important marketing factors are either greatly or rapidly affected by public action.

Another group of factors is involved in the private owner's consideration of production costs. Whether growth is relatively slow, as in many of the Central region hardwood forests, or rapid, as in the southern pine of the Pacific Douglas fir, is important. The ability of the forest to restock naturally and rapidly, if given a chance, as in the South and New England, is a very real advantage when compared to the more slow and uncertain natural restocking in the pine regions of the West. Most properties involve planting of denuded lands; cheap artificial restocking, as in the South and Lake States, is an advantage over costly planting, as in the western forest regions.

Cost of protection against fire and other agencies must be incurred annually, and mount to a major item in the cost of growing forests. The exceedingly high costs in such regions as the northern Rockies and Pacific are a marked disadvantage when compared to the lower protection costs in New England and the South. Many of the measures to obtain forest production, such as reservation of seed trees from cutting, protection of young advance forest growth, prevention of loggings fires, must be done as part of the logging operation. Regional differences in the ease and cost of these are material and affect the opportunity for private forestry.

Particularly in the Pacific region, careful selection of the high-quality trees for cutting gives the owner a chance to increase immediate returns—an opportunity less evident in many of the eastern regions. Notably in New England and the South, the forest owner can draw on resident, cheap, rural labor, which depends in part on other than forest work, usually on agriculture. Such regions have in this respect a great advantage over the Pacific region, where non-resident imported labor must be depended on largely.

Forest lands in the South often can be leased for the hunting privileges, and in the southern Rockies for grazing privileges, thereby reducing current ownership costs. In regions such as the northern Rockies, where returns from other than forest uses are impossible, the owner is obviously at a relative disadvantage. The financial ability of the State to carry a large share of the cost of protection, as in New England and the Middle Atlantic regions, is an important aid to the private owner, when compared to lack of financial ability in much of the South and in the northern Rockies.

AID OR HINDRANCE DUE TO PUBLIC ACTION

The foregoing costs-of-production factors are not greatly nor rapidly affected by public action, but other factors of this nature are so affected. For example, where trespass laws give real protection to the forest owner, as in the Pacific region, he is more favorably situated than where he lacks adequate protection, as in the South. Where local taxation is high in relation to the real income-producing value of the forest property, the recurring costs necessarily are an unfavorable factor. In the States of the New England and Middle Atlantic regions, where the non-Federal share of fire-control costs are paid by the State from general funds, the forest owner is better off than in the northern Rockies and Pacific regions, where he is assessed with most or all of the non-Federal share. States with regulatory laws regarding slash disposal, reservation of seed trees, etc., so far quite generally leave the private owner to assume the extra costs to the degree the laws are enforced. The probability that costs made necessary through regulation will be assumed by the State is a factor to be considered by the owner.

A very important consideration is the usual character of fires in the region, whether highly destructive, as in the northern Rockies and Pacific regions, or only partly destructive, as in the South. The conflagration hazard is high in such regions as the Lake and northern Rockies, even under organized protection, and low in the South and New England, and the regional differences bear importantly on the private opportunity. Forest properties under the threat of destructive diseases such as the blister rust, and insects such as the gypsy moth and western pine beetles, are naturally less attractive than the southern forests where such threats are absent.

Besides these factors of inherent risk to the crop, the owner must consider others which depend on public action. Whether public opinion toward fire control is strongly favorable, as in New England and elsewhere, or apathetic or hostile as in much of the South, carries a good deal of weight. The existence or nonexistence of a State fire-control organization, and whether it is strong or weak, greatly affects the likelihood that the growing forest will be protected.

LOCAL OPPORTUNITIES FOR PRIVATE FORESTRY

Yet another group of factors revolve around the existing opportunity for private forestry. Part of them are not greatly nor rapidly affected by public action. For example, where a high percentage of private forest land is seriously depreciated, as in the Lake States, the cost of restoring productivity and rebuilding a growing stock, makes the private opportunity less attractive than in the New England and Pacific regions, where the proportion of depreciated land is lower. Likewise, where a relatively high proportion of the productive forest land has saw timber, as in the West, the opportunity is better than where a very high proportion has only cordwood, as in the South.

Regions with an excessively high installed mill capacity usually have very active competition for stumpage, and make it difficult for individual owners to block out their holdings. Lack of this competition as in some parts of the West, gives a better chance for private forestry. So, too, where there are large areas of public stumpage managed to obtain sustained-yield operations, which serve as a balance wheel for private stumpage, as in the western regions, the private owner has a far better opportunity than where all or nearly all the stumpage is in private hands.

Where the key species in the forest are general utility woods, such as southern pine and Douglas fir, the wider markets available are a real advantage over those accessible to specialty woods, such as some of the soft pines.

In the western regions to date most logging operations have involved very high capital investments in mills, logging equipment, and transportation systems. Where such high investment operations are necessary, the private owner is at a disadvantage compared with owners in some of the eastern regions where less elaborate and costly operations fit the smaller timber and easier topography.

REGIONAL TRENDS

Aside from all of the above factors bearing on marketing, cost of production, risk to the crop, and existing opportunity, the owner is likely to be influenced by current regional trends. A strong tendency to land abandonment by other forest owners, as in the Lake States and parts of the Pacific region, is indicative of the judgment of landowners that forest-growing opportunities are poor. General lack of land abandonment, as in New England, on the contrary, expresses general belief by landowners that a fair opportunity exists.

Then, too, the social tradition to hold land as the primary source of wealth is a powerful factor in New England, whereas the more typical attitude of western owners is to regard land as simply a medium for the immediate exploitation of the wealth it produces.

Of these factors, and there are many others, some may assume major importance in one broad type and region and may be inconsequential in another region. Furthermore, what may be a true answer as to a specific factor for a region as a whole, may not be correct for a given forest property in that region.

BALANCING LOCAL ADVANTAGES AND DISADVANTAGES

The exact value and relative weight of each factor are not readily ascertainable and even if these could be determined, the relative opportunity for private forestry in each region could not be stated with mathematical exactness. Recognizing these inherent difficulties, an approximation of the relative opportunities for private forestry has nevertheless been attempted by weighing these factors for each major type and region. Each major forest region contains two or more forest types, and only rarely do all the types in a region bear the same rating as to private opportunity. For example, in the Southern region, the pine type of the coastal plain rates very high, whereas the oak-chestnut-yellow poplar type of the Appalachians in the same region rates relatively low and the oak-pine type of the Piedmont Plateau is intermediate. Similarly in the Pacific region the Douglas fir type of the northwest rates as superior in private opportunity to the ponderosa pine type of the same region. Simply as a matter of convenience in tying the private opportunity ratings to the classification of forest regions which is used throughout this report, an average rating for each region has been estimated, weighed to recognize differences in area of types within regions.

By this means the several regions may be divided into four broad classes of opportunity for private forestry, as follows:

Class 1. Most favorable: New England, Middle Atlantic, Central.
Class 2. Generally favorable: South.
Class 3. Only locally favorable: Lake, Pacific.
Class 4. Least favorable: North Rockies, South Rockies.

This does not, of course, mean that all properties are a favorable chance in the regions at the top of the list, nor all at the bottom an unfavorable chance. Only a detailed rating of each property can determine its individual opportunity. Any attempt to carry the interpretation of the rating beyond its significance as a broad average would be wholly unwarranted. It is a relative, not an absolute rating. Neither should it be interpreted by any private owner, regardless of the region in which located, as evidence that he cannot profitably practice forestry. The Pacific region has been placed in the third class, but yet its fine stands of remaining virgin timber, the rapid growth of species, and the high quality of the product combine to present locally some of the most favorable opportunities for private forestry.

The trend of forest-land abandonment by private owners in all regions may similarly be rated on a relative scale and classified by regions, as follows:

Class 1. Little abandonment: New England, Southern Rockies, Middle Atlantic.

Class 2. Some abandonment: Central, South.

Class 3. Considerable abandonment: Lake, Pacific, North Rockies.

Roughly, the highest rates of land abandonment coincide with the lack or local limitation of favorable opportunity for private forestry, and the lowest rates with most favorable opportunity. The small amount of abandonment in the South is due in part to the State laws dealing with tax delinquency and to more or less lax administration of them. The southern Rockies although classed as least favorable to private ownership, shows little land abandonment. This is due to the fact that in this region lands can be leased for grazing.

In all probability most, if not at all, owners who have abandoned land have simply considered the likelihood of any profit in holding their property in a very general way. It is unlikely that many have made a detailed factual analysis of their chances. But the mass effectiveness of the numerous adverse forces, focusing finally in some regions into a predominant push toward land relinquishment, can hardly be doubted. The rates at which forest lands are abandoned through tax delinquency express a gradual decision by scores of individual owners to give up a struggle which more and more appears to be a losing one, and which has been accentuated to some degree by the depression. It is to be suspected, however, that a detailed analysis would indicate basic reasons for the regional distribution of forest land abandonment.

It can only be concluded that a trend in the direction of land relinquishment by private owners of forest land, which is based on so large a number of inherent factors, may acquire even further momentum.

EFFECT OF PRESENT PUBLIC SUBSIDIES

Public aid in varying degrees has been given to forest owners in protection against fire, insects, disease, and in deferred or lowered taxes on immature, growing forests. These forms of aid and what they have accomplished are discussed in other sections of the report. Both kinds and amounts of public aid have varied widely from State to State, and they are considered here merely as they have influenced retention of forest lands in private ownership. For example, public aid in fire control has been given in many States, yet this has not in itself, so far, materially influenced retention of private ownership of forest lands. In table 4 present expenditures for fire control and the amount contributed through public aid are shown.

A comparison of different regions indicates, for example, that in both the New England and the Lake States regions almost the entire cost, and in nearly equal amounts, is now assumed by the public. But in the former, there is very little land abandonment; in the latter a great deal.

The conclusion is warranted that public aid in fire control is not a substantial factor in keeping lands in private ownership, even where the total cost is paid by the public. It is, however, a good public investment insofar as it keeps lands more productive than they would otherwise be.

The total expenditures from all sources for protecting private forest lands against fire averaged $5,400,000 for 1926–30 and was $7,221,000 in 1931. Of the latter amount about 80 percent was paid by the public, and 20 percent by the landowner. The estimated needs total $19,828,000, of which public agencies would pay $14,871,000 a year, if the same proportionate division is maintained. It seems at least possible that, as the States and the Nation increase their appropriations and approach this estimated total of needed public aid to private landowners, the public may be much more inclined to assume the additional costs of full ownership and realize the concomitant powers and benefits.

TABLE 4.—*Present and needed annual expenditures for fire control on State and private lands*

[Amounts in cents per acre]

Region	Present expenditures [1]	Paid by public [1]	Estimated costs required	Region	Present expenditures [1]	Paid by public [1]	Estimated costs required
New England	1.94	1.92	2.86	Pacific Coast	3.28	1.60	6.43
Middle Atlantic	2.77	2.77	3.35	North Rocky Mountain	5.90	1.65	8.39
Lake	2.01	2.00	4.24	South Rocky Mountain	[2].89		1.39
Central	.40	.40	2.55				
South	.43	.34	5.43				

[1] Average 1926–30.
[2] Incomplete records of expenditures on private land in New Mexico.

Tax-relief laws on forest lands, cut-over stands, or growing forests exist in about 30 States yet few owners have taken advantage of them. About one and one half million acres is listed out of the total forest area in private ownership, the average being below 0.5 percent of the total area. The maximum is reached in Oregon at 3.1 percent. The preferential tax, a form of public aid, has not so far influenced retention of forest lands in private ownership, or modified materially poor treatment of forest lands. Apparently, judging from present actions by owners, the preferential tax holds little interest for them.

A very generalized tabulation of costs for a timber property will show 5 to 10 cents per acre per year for fire control, 15 to 25 cents for timber management, and 20 to 50 cents for taxes. The public may go so far as to assume the costs of the first item, but unless the forms and amount of public aid are greatly expanded the owner will have to meet the others.

In the main, the conclusion is warranted that public aid so far has been only a minor factor in keeping forest lands in private ownership. Other conditions not affected by public action have been far more controlling.

In the analysis of factors affecting permanence of ownership of private forest lands, some not greatly nor rapidly affected by public action, and others that were so affected were listed. If there were nothing to forestry but fire control then public aid would have high potentialities for keeping lands in private ownership and management. But since other expenditures are necessarily involved—and such as are unlikely to be assumed by the public—public aid can hardly be regarded as a general formula to keep forest lands in private ownership.

Where cash returns must be deferred for years, it seems unlikely that the owners will regard private forest properties as favorable investments. It also seems unlikely that public aid will assume all costs of ownership, leaving title to the land and future income to the private owner.

The limitation of Federal aid in fire control is indicated by the fact that over 191 million out of nearly 420 million acres of State and private forest land are still without organized fire control. At the recent rate of progress it will require 22 years to get organized fire control extended to all forest lands needing it. Whatever the reasons for this lack of progress, it has to be recognized that public aid has sharp limitations.

PROBABLE ACREAGE OF INDUSTRIAL TIMBERLAND RETAINED IN PRIVATE OWNERSHIP

REGIONAL DISTRIBUTION

On a previous page the opportunities for private forestry by regions have been roughly classified by means of the examination of the factors which ordinarily affect profits in timber growing and manufacture. The analysis indicated several of the major regions in which the private forest landowner generally has a relatively good chance. But it does not follow, even in such a region as New England, which was rated very high, that all forest land now in private ownership will remain there. Public interest may justify and dictate ultimately a policy of considerable area in public forests. Several of the States in this region have acquisition programs for State forests and State parks, and some of the forest land will probably come into public ownership because of high watershed and recreation value. Where land abandonment occurs in New England, further extension of public forests may be expected. Other forms of public ownership, such as town forests, are already in existence and seem destined to expand.

On the other hand, in the regions with the least favorable chance for permanent private forestry, it is very unlikely that all lands will pass to public ownership. Some forest properties will be far superior to the regional averages for permanent private enterprises and some lands will possess peculiar values for income-producing recreational use that will make them acceptable private investments for such purposes as country estates and game preserves. Thus, even in the least favorable regions some of the private land may be expected to remain in that status.

In regions shown in opportunity classes 2 and 3, that is generally favorable and locally favorable, a larger proportion of the area is likely to stay in private hands than in the least favorable regions, and a smaller proportion than in the most favorable regions. In 1931 a group of State forest officials of the New England States studied the question of the ultimate extent of public ownership of forest land in that region. Their conclusion was that 15 percent of the total forest area would be acquired by the public, in addition to that now owned. This determination has been accepted as a measure of the probable extent of additional public ownership in regions where the most favorable opportunity for private forestry exists. In the North Rocky Mountain region an analysis of the probable plans of the owners of the larger tracts of private forest land indicated that not over 10 percent of the forest land was likely to remain permanently in private ownership. In the regions least favorable for private forestry, this figure has been used. It has then been assumed that in the intermediate classes (2 and 3) 60 and 35 percent, respectively, will remain in private ownership. On these broad assumptions an approximation of probable future private ownership of forest land, exclusive of farm woodlands is attempted. In table 5 are presented the acreages now in private ownership, the opportunity classification for private forestry, and the percentage and area likely to remain in private ownership. The indication is that, for the United States as a whole, more than 40 percent of present private holdings will go into public ownership, involving an acquisition program of some 115 million acres. Of this total 73 percent will come out of the eastern regions, but will represent only 36 percent of the present private forest land area in the East. The 27 percent from the western regions, on the contrary, represents 81 percent of private holdings.

TABLE 5.—*Possible future distribution of ownership of commercial forest land now privately owned, exclusive of farm woodlands*

Region	Present commercial private land	Opportunity class	Commercial forest land to remain in private ownership		Total public acquisition
	Million acres		*Percent*	*Million acres*	*Million acres*
New England	19.6	1	85.0	16.7	2.9
Middle Atlantic	15.5	1	85.0	13.2	2.3
Lake	34.8	3	47.5	16.5	18.3
Central	31.3	1	72.5	22.7	8.6
South	129.4	2	60.0	77.6	51.8
Pacific Coast	27.9	3	22.5	6.3	21.6
North Rocky Mountain	5.9	4	10.0	.6	5.3
South Rocky Mountain	5.1	4	10.0	.5	4.6
Total	269.5	----------	57.2	154.1	115.4

Although this estimate can be regarded only as having an indicative value, it does signify that unless several miracles occur shortly, the problem of public ownership of forest lands will have to be recognized and attacked on a very much more comprehensive scale than has been previously envisioned.

DISTRIBUTION BY GROWTH CLASSES OF INDUSTRIAL TIMBERLAND

The problem of future ownership distribution can be approached by another method, namely, the present condition of the land. The private forest land owned by other than farmers is thus classified in table 6. Here the areas that may remain in private ownership are estimated on the basis of realizable and more immediate prospective value. Thus it is assumed that private ownership would retain the bulk of the 91 million acres still possessing realizable timber values, and in the main offering a business opportunity to private ownership to practice private forestry. In addition it may retain about two thirds of the cordwood area, about one third of the fair to satisfactory restocking area, and only a small fraction of the 54 million acres now so devoid of forest values, owing to destructive logging and fires, that before it can again produce a forest income it must be planted with trees and protected against fire and other destructive agencies for 25 to 100 years.

Even with liberal public assistance in planting and protection, the cash expenditures needed to restore realizable crops on the "poor to nonrestocking" areas, and the period of waiting for a cash income, make the bulk of such lands exceedingly unattractive for private ownership. Public ownership of one kind or another appears inevitable for a very large part of this acreage. Whether it is purchased, or whether the public agencies wait to acquire the land through the slow process of tax-delinquency, the eventual outcome is likely to be the same. It will come into public ownership because nonproducing forest land is a liability to private owners and neither eventual possibilities nor immediate public assistance are likely to offset this stubborn economic fact.

TABLE 6.—*Possible future distribution of ownership on the basis of present condition of private land (other than farm woodland)*

Condition of land	Total present area of private land	Area remaining private	
	Million acres	*Million acres*	*Percent*
Total saw timber	91	91	100
Total cordwood	62	40	65
Total fair to satisfactory restocking	63	20	32
Poor to nonrestocking	54	5	9
Total acreage	270	155	

About 125 million acres of the privately owned forest land other than farm woodland has been cut over but has a partial reserve of unmerchantable trees and young growth or trees of cordwood size. The stocking varies greatly, and the attractiveness of this class of forest land as a permanent private ownership opportunity varies just as widely. On millions of acres of pine land in the South, for example, cash returns can be obtained when even a partial forest stand is both young and small. Naval stores, posts, poles, and pulpwood can be sold readily, and most of the land is readily accessible so that scattered trees and products can be harvested.

In much of New England likewise an income can be obtained from the young, partially stocked forests through sale of cordwood, posts, poles, and other special products of small trees. Under such circumstances, and where markets are close at hand, many of the partly stocked forest lands offer a possible or even an attractive return to the private owner. In most of the West, on the contrary, partially restocked forest land offers little opportunity for current returns through sale of forest products obtainable from small trees. Until the trees reach saw-timber size, the owner must pay carrying and protection costs without in the main realizing any current income. Transportation charges make it uneconomic to harvest such products as cordwood and posts.

In the Lake States the rapid progress of land abandonment by private owners indicates clearly that unstocked and partly stocked forest lands are generally unattractive for permanent private ownership.

Possibly some two thirds of the 63 million acres fair to satisfactory restocking area and one third of the cordwood area may pass finally to public ownership. On this basis the analysis indicates about 115 million acres of the 270 million total as the eventual area in public ownership.

ADEQUACY OF ESTIMATES

These estimates may be materially wide of the mark; the true answer cannot be determined for many years. But it is essential to recognize that a powerful and large-scale trend away from private ownership and into public ownership is already under way and that it is a natural phenomenon, arising from fundamental conditions. It is distinctly not an artificial trend, induced by political theory or by any efforts of public forestry agencies to displace or drive out private ownership.

This conclusion is inevitable as the sharp differences between the several States and regions are examined. Where forest lands are in small ownership, close to markets, where the products of young and small trees are readily salable, and thus where the owner of forest land can obtain current income at least sufficient to offset current expense, there land abandonment and distress sales of cut-over lands to public agencies are not major problems. On the contrary, where forests and markets are far apart, where only the products of large trees are salable, and where consequently the owner cannot offset his current expenses through current income, there the private owners are getting rid of cut-over lands or intend to do so. The question, then, is not whether it is desirable that forest land remain in private ownership to the degree that now obtains, or to some other specified degree. With or without public policy or financial aid, or any other conscious and deliberate action, individual private owners are deciding their own course of action.

It is manifest that past and current abuse of forest land by the owners has enormously reduced the acreage on which even a gambling chance of economically successful private forestry remains. These destructive practices—heedless logging methods, wholesale burning of slash, clear cutting, and inadequate fire control—have been recognized for years by forest landowners, conservationists, and foresters. The remedies recommended and applied so far have consisted principally of public aid in fire control and, in some places, local regulation laws requiring fire control and leaving of seed trees. Some private owners in every forest region have on their own initiative applied forestry practices to their properties, but only a very small fraction of the total private forest land has thus been handled. The accumulated 55 million acres of unproductive cut-over forest land taken alone is in large part the answer to the question whether major changes in land ownership are desirable.

If public aid consistent with national policy could keep lands now cut over or to be cut over in privates ownership, under forestry mangement, and producing forest crops, no problem would exist. But the conclusion is inescapable that as to a very large area, the private owner will decline to continue to do much even with present public aid. Whether the estimated 115 million acres of present private areas that private ownership will wish to relinquish remains untended and unmanaged as "the new public domain" under involuntary ownership by towns, counties, or States, or is held and managed as public forest property, it will be public land, and a public problem.

THE PROBABLE FUTURE OWNERSHIP OF ABANDONED FARM LAND

The area of farm land abandoned for agricultural use (see section "Agricultural Land Available for Forestry") now totals 51,717,000 acres east of the Plains and, it is estimated, will be increased by perhaps 25 million acres within the next 20 years. Possibly as much as one third is on occupied farms. The bulk of this will remain in private ownership, so long as the farms are occupied. Such land generally constitutes an integral part of the farms and is favorably situated for private forestry use. Although most of it will have to be planted to produce a timber crop within a reasonably short period, this will require very little cash expenditure. Most of the States furnish forest planting stock at low or nominal prices for planting on farms, and the farmer can do the planting himself. Many farmers have planted waste land during the last few years, and the extent of such work is steadily increasing.

Private owners are less likely to reforest the idle land on abandoned farms. In most cases they hope to sell it, usually to some one who will attempt to farm it. In many cases the reason for abandonment is erosion induced by bad agricultural practices. Washing away of the topsoil and gullying are common causes of abandonment.

Most of such land is submarginal for agriculture. Attempts to farm it will usually result in loss to the individuals and additional social and economic burdens on the communities. In hilly country, serious erosion and consequent damage to public and private interests may result. As long as such land is held in unstable ownership it will constitute a threat to the community welfare, not only locally but within a wide territory. The only way to insure stable ownership and use will be for the public to acquire the land and manage it under a definite program. In public ownership, the use of the land can be controlled. It will be possible both to prevent uneconomic use contrary to the best interests of the individuals and to society and to bring about a productive use that will benefit society.

Much of this land will gradually drift into public ownership by way of tax delinquency, as indicated by the trends in States and regions where agricultural land abandonment is most active. The processes of erosion have become so pronounced that on much of the abandoned area it is too late to remedy the condition through prompt adoption of such agricultural practices as terracing and contour plowing.

In some regions it is already possible to block up considerable areas of land that have thus reverted to public ownership, including both forested and idle land. In general, however, public acquisition by this method cannot proceed systematically and the process entails great economic distress to individuals and communities. Systematic and fairly rapid acquisition by purchase, if necessary, would be desirable. In this way bad practices can be halted more promptly and restorative practices, such as fire protection, planting, and conservative grazing, can be begun.

Extensive land abandonment is an index of local poverty, and tends to aggravate it. Towns and counties with large areas of idle land are likely to be financially weak and to require heavy subsidies from the States for the support of roads, schools, and other public functions. They cannot, therefore, be expected to invest much cash either in acquiring forest land or in rehabilitating and managing it even where it is acquired at little or no cost. Outside capital will be required. This will have to be supplied by the States or the Federal Government.

Where the area of idle land plus land already in forest constitutes a relatively large proportion of the total land area, and where agricultural use of the remaining land is generally submarginal and tending to decline, or is injuring the public welfare through erosion, silting, and disturbance of stream flow, public forestry is indicated.

Probably at least half of the 50-odd million acres of idle land that is now available for forestry, and much of the land that may be abandoned for agriculture in the future, will eventually find its way into public forests. It is safest to assume that about 50 million acres previously classed as farm land will come into public ownership in one way or another. The regional distribution of this class of land is shown in table 1.

THE PROBABLE FUTURE OWNERSHIP OF WOODLAND ON FARMS

In addition to the 52 million acres of abandoned farm land now available for forestry, and the possible 25 million acres to be available subsequently, about 127 million acres of commercial forest land is owned by farmers in the form of woodlands. Its regional distribution is shown in table 1. Some part of this 127 million acres is attached to the 52 million acres of abandoned agricultural lands. Without extensive field surveys there is no way even to approximate the woodland area so involved. It is probably not less than 25 million and may be 50 million acres.

The fact that most farm woodland is readily accessible to transportation facilities—and that a large part of it is above the average in potential productivity for timber—favors continued private ownership and management. Woodlands on many farms are closely linked with the farm economy. The farmer depends on them for firewood, posts, and other farm timber. They shelter his fields and buildings and livestock against excessive winds and extremes of heat and cold. They give variety to the scenery and contribute in many ways to the pleasantness of his environment. In numerous instances they also supply a cash crop which he can harvest and market when other crops fail, or at times when other farm work is slack. They require very little investment except the farmer's own time, and the carrying charges are commonly very small. In many cases, the farm woodland constitutes a sort of land reserve, upon which the owner can draw when he wishes to increase his acreage of crops or pasture.

It is likely, then, that a large proportion of the woodland on permanently established farms will remain in private ownership. Its area will fluctuate more or less, as some forest is cleared and as other land reverts to woods. For the most part, the owners will have sufficient interest and opportunity to keep it reasonably productive.

The public can best fulfill its responsibilities by showing the owners how they can improve their practices by assistance in marketing forest products and by help in combating pests, diseases, and fires. The fire risk, incidentally, generally will be much less than in the case of the larger industrial forest tracts. It would not be practical for the public to acquire any considerable area of woodland on established farms, and there is little occasion to attempt it.

In localities where a large proportion of the land is submarginal for farming, and where many of the existing farms are consequently on an unstable basis, the situation may be quite different. There a large part of the land in farms is woodland (in naturally forested regions) and the degree of farm abandonment is likely to be high. In many instances the woodland is fairly well stripped of readily realizable values before it is abandoned, so that there is little incentive for other individuals to acquire it. In numerous localities of this sort the maintenance of a forest cover is important for protection of soil and watersheds. The existence of widely scattered farms may entail heavy expense for roads and schools that could be eliminated by public acquisition of the land. In some localities there is both opportunity and justification for public acquisition of considerable areas of farm woodland, along with the unwooded land that should be taken out of agricultural use. Much of this kind of land is coming into public ownership through tax delinquency. It may be desirable to speed the process up and bring it about in a more orderly mnaner—and one less cruel to the landowners—by deliberate purchase.

An estimate of the probable future distribution of ownership for woodlands on farms can only be an approximation. It is evident that large areas of commercial forest land in all regions will eventually come under public ownership and management. Definite public forest units will naturally be blocked out, as they are now in the purchasing of forest lands for State and Federal forest purposes. Within these units, certainly abandoned agricultural lands and the woodlands attached to them will come within the price range of public purchase. It is reasonable to assume that other farm woodlands within the units, attached to operating farms, will to a large extent be on the market, also. Tenant farming of hill farms—those within the future public forest purchase units—is exceedingly common. The farm as a whole is of interest to the owner only as a source of immediate revenue, which comes mainly from the acreage actually farmed. It is to be expected that once the woodland is of interest to a possible purchaser, it will be on the market. In many of the forest regions, the woodland on farms is not an integral part of the farm itself, and the operation of the farm land does not depend on the ownership of the woodland. None of these general statements is universally applicable.

One basis for estimating the eventual public acquisition of farm woodlands is to assume that the public will get the same proportion as it is estimated to get of other private woodlands. In a very broad way this means that within public forest units, the public will acquire about the same proportion of both classes of private forest land (table 7).

On this basis the total area of private land which may eventually come into public ownership for forest purposes is 115 million acres from commercial forest owned by other than farmers, 50 million acres of abandoned agricultural land, and 47 million acres of woodland on farms, a total of 212 million acres.

The method of estimating used goes at the problem from the angle of what lands the public will need to take care of because they are no longer attractive to private ownership. But clearly, the magnitude of the public acquisition job should also be estimated from the direction of what is needed to insure realization of the public purposes of timber supply, watershed protection, recreation, and wild life. Estimates of public ownership for these purposes are made in the following pages.

TABLE 7.—*Possible future distribution of ownership of commercial woodland on farms*

Region	Present area woodland on farms	Percentage to public ownership[1]	Area woodland to public
	Acres	*Percent*	*Acres*
New England	6,402,000	15	960,000
Middle Atlantic	9,461,000	15	1,419,000
Lake	14,281,000	52.5	7,498,000
Central	32,158,000	27.5	8,843,000
South	57,866,000	40	23,146,000
Total, East	120,168,000	34.8	41,866,000
Pacific Coast	5,099,000	77.5	3,952,000
North Rocky Mountain	1,413,000	90	1,272,000
South Rocky Mountain	43,000	90	39,000
Total, West	6,555,000	80.3	5,263,000
Grand total	126,723,000	37.2	47,129,000

[1] Assuming percentage of farm woodlands to public ownership will equal percentage of private industrial forest to public ownership. (See table 5.)

PUBLIC OWNERSHIP AND TIMBER PRODUCTION

PRESERVATION OF GROWING STOCK A VITAL CONSIDERATION

Because of their relation to the question of ultimate ownership of forest lands, it may be well to review here a few of the more pertinent findings in the detailed discussion of growing stock given in an earlier factual section, "Present and Potential Timber Resources." Among these is the certainty that forest land with balanced distribution of saw timber, second growth, cordwood, and smaller age classes can be made to contribute indefinitely and in a very large way to the Nation's economic welfare. So far in our national history, we have merely been harvesting the stored up old growth of centuries past, and as this has disappeared we have proceeded with the next process, cutting heavily and repeatedly into the usually inferior volunteer second growth and cordwood stands. Excepting where the most destructive forces have been permitted to sweep a forest, some kind of forest growth has followed, even where unregulated cutting or promiscuous, uncontrolled fires have taken place, but with serious impairment of forest values. This process cannot continue indefinitely without depleting the forest capital—the growing stock that is the sole base on which saw timber can be produced—and without depreciating the forest soil that influences the growth rate of the timber crops. The facts that a great deal of our land is suitable for timber production, that large areas in the West still have considerable stands of untouched virgin stumpage, and that some kind of a forest has often followed even where cutting has been heavy, have masked the critical situation of a continually mounting deficit in our forest growing stock. Thus we have the anomaly of great stretches of potentially highly productive forest lands but a dearth of growing stock both in total amount and in regional distribution.

In the past few years a further factor has operated to create a false confidence in the inexhaustibility of our timber supply. Large blocks of virgin stumpage in the Pacific Northwest have been liquidated under apparently uncontrollable economic pressure, which has, much too rapidly, forced timber into an already glutted market. At the same time, second-growth timber in the South, manufactured into lumber at low costs, entered the same competitive market, further depressed prices, created discouragement in the timber holder and lumber manufacturers on the one hand, and gave the public the false hope of unlimited timber supplies. Only where cutting out of a forest has been followed by the inevitable complete breakdown of the dependent industrial life, has there been a full appreciation that forest wealth can be dissipated. Even where this has taken place over a wide region, the local effects only have been recognized, and the national aspects and interests have been largely ignored.

World-wide economic changes have directed public attention to the need for national planning. How lands and resources are handled, obviously, must be carefully considered in any major national planning scheme. Present and potential forest lands make up between one fourth and one third of our total land area which is capable of producing abundant timber crops if some rational, Nation-wide plan of management were applied. If we are to enjoy the sustained and cheap abundant supplies of raw materials that forests can produce, we must plan for it in a systematic way.

PRESENT CONDITION OF GROWING STOCK

The data now available, at best approximate, indicate that a Nation-wide plan is needed to insure a continuous supply of timber of at least 17 to 18 billion cubic feet annually, which is about the amount now used in the United States. Our present growing stock is deficient in two respects to accomplish this purpose; it is below the total needed, and its distribution between important forest regions is badly out of adjustment.

The regional ratios of present timber stand to actual growing stock required to maintain a growth of 17.7 billion cubic feet annually are as follows:

	Decimal ratio
New England	0. 9
Middle Atlantic	. 6
Lake	. 3
Central	. 4
South	. 4
Pacific	1. 9
North Rocky Mountain	1. 6
South Rocky Mountain	2. 7
All regions (weighted)	. 8

The important southern region, still a factor in timber production, has only four tenths of the growing stock needed, and cannot continue to furnish its quota of timber for the national needs under the proposed budget on the present basis of management and intensity of cutting. Even in the western regions, unless care is exercised, the apparent surplus in growing stock can be dissipated unless plans for careful forest management are initiated at an early date and positive corrective measures taken. But under any plan there will be a shortage of saw timber before an annual growth of 17.7 billion cubic feet is attained unless existing information is later found to be in error. The western surplus of mature timber, if well husbanded, can partially bridge this gap.

AREAS NEEDED TO SUPPLY NATIONAL TIMBER REQUIREMENTS

A plan providing conservatively for our national timber needs, outlined in the factual section already cited, sets up both the land area of 508.6 acres to be used and the intensity of management, with which to build up the growing stock and assure an annual production equal to estimated normal requirements. In table 8 the data are summarized.

TABLE 8.—*Possible regional allocation, by types of management, of area available for timber use*

[Areas given in millions of acres]

Region	Total area [1]	Area for intensive forestry	Area for extensive forestry	Area for simple protection		
				Forested land, relatively— Favorable	Forested land, relatively— Unfavorable	Not likely to restock [2]
New England	23.1	5.0	12.0	1.8	0.7	3.6
Middle Atlantic	30.1	6.0	14.0	2.1		8.0
Eastern regions	53.2	11.0	26.0	3.9	0.7	11.6
Lake	60.7	11.0	30.2	5.0	5.0	9.5
Central	75.6	10.0	41.8	5.9	8.6	9.3
South	205.9	30.0	131.5	14.8	17.8	11.8
Middle and southern regions	342.2	51.0	203.5	25.7	31.4	30.6
Pacific Coast	57.4	7.0	33.0	4.8	8.8	3.8
North Rocky Mountain	26.8	.5	10.0	4.1	10.4	1.8
South Rocky Mountain	29.0	.5	6.4	2.2	18.4	1.5
Western regions	113.2	8.0	49.4	11.1	37.6	7.1
All regions	508.6	70.0	278.9	40.7	69.7	49.3

[1] Includes the 494.9 million acres of present commercial forest area and the 54.7 million acres of farm land now available for forestry, with reductions of 2 million acres of forest land to be cleared for agriculture in the West and of 39 million acres for recreation and other purposes.

[2] Residual area of denuded commercial forest land and agricultural land available for timber use, after allowing natural restocking of 42.9 million acres and planting of 25.5 million acres.

PROBABLE FUTURE DIVISION OF RESPONSIBILITY BETWEEN PUBLIC AND PRIVATE OWNERSHIP

The acreage required in the budget is made up of commercial forests in private ownership, the farm woodlots, and abandoned agricultural lands available for forestry. It also includes forest lands now in public ownership on most of which some form of forest management is already under way. The plan, however, requires considerable intensification of management even on the publicly owned lands. It is assumed that the degree of management required in the plan will be applied to the present publicly owned lands susceptible of and available for such treatment. If these areas are deducted from the total areas set up in the budget, the remainder represents the areas for which further provision of management must be made. In Table 9 these data are given for the several forest regions.

If the 84.6 million acres now in public ownership are handled according to the plan, there still remains 374.7 million acres which likewise require specific forms of management. This means that in addition to what can be accomplished on lands now publicly owned, intensive forestry must be practiced on 62.3 million acres, extensive forestry on 243.3 million acres, and in addition adequate fire protection on another 69.2 million acres. The question must be asked: How far can dependence be placed on private capital and ownership to initiate and carry out a substantial part of such a plan?

TABLE 9.—*Total area needing different kinds of management, after deducting present public forests, by regions*

[Value given in millions of acres]

Explanation	New England	Middle-Atlantic	Lake	Central	South	Pacific Coast	North Rocky Mountain	South Rocky Mountain	Total
Total area needed for intensive forestry	5.0	6.0	11.0	10.0	30.0	7.0	0.5	0.5	70.0
Area available in present public forests	.5	1.0	2.0	.4	1.0	2.0	.3	.5	7.7
Additional area required	4.5	5.0	9.0	9.6	29.0	5.0	.2	0	62.3
Total area needed for extensive forestry	12.0	14.0	30.2	41.8	131.5	33.0	10.0	6.4	278.9
Area available in present public forests	.8	.5	2.0	.3	2.0	15.0	8.7	6.4	35.7
Additional area required	11.2	13.5	28.2	41.5	129.5	18.0	1.3	0	243.2
Total area favorable, requiring simple protection	1.8	2.1	5.0	5.9	14.8	4.8	4.1	2.2	40.7
Area available in present public forests	.1	.5	.5	0	.2	2.0	4.1	2.2	9.6
Additional area required	1.7	1.6	4.5	5.9	14.6	2.8	0	0	31.1
Total area unfavorable, requiring simple protection	.7	0	5.0	8.6	17.8	8.8	10.4	18.4	69.7
Area available in present public forests	0	0	.2	0	0	4.0	10.4	17.0	31.6
Additional area required	.7	0	4.8	8.6	17.8	4.8	0	1.4	38.1
Total area needed	19.5	22.1	51.2	66.3	194.1	53.6	25.0	27.5	459.3
Total area available in present public forests	1.4	2.0	4.7	.7	3.2	23.0	23.5	26.1	84.6
Additional area required	18.1	20.1	46.5	65.6	190.9	30.6	1.5	1.4	374.7

The task of providing continuous management for timber production on 374.7 million acres of forest land is a huge one. Private holders of stumpage and the farmer with his farm wood lot must be depended on to contribute a large share to the undertaking even if public agencies greatly expand their present efforts. How far private enterprise can go depends not only on present trends, but on the potential opportunities for industrial and farm forestry. On pages 891 to

985 of this report the opportunities for private forestry were considered and appraised for each important region.

On the basis of the assumed percentages of forest lands in each region likely to be retained by private owners as given in table 5, the 374.7 acres now in private ownership and required in the budget for timber production have been allocated in table 10 into what is likely to remain in private ownership and management and what must necessarily be taken up in public ownership.

The figures in table 10 were arrived at in the following manner: For each region the percentage shown in table 3 was applied to the areas needed under intensive and extensive forestry. Thus in the northeast region, it is expected that 85 percent will remain in private ownership. The present private lands required in the budget for intensive forestry are 4.5 million acres; therefore, 3.8 million acres is assigned for continued private ownership and 0.7 million acres must be taken up in public ownership.

TABLE 10.—*Probable division of acreage now in private ownership as between different kinds of management and private and public ownership*

[Values given in millions of acres]

Region	Under intensive forestry		Under extensive forestry		Protection only—fair land		Protection only—poor land		All management		All lands
	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private	
New England	0.7	3.8	1.7	9.5	0.8	0.9	0.6	0.1	3.8	14.3	18.1
Middle Atlantic	.8	4.2	2.0	11.5	.8	.8	0	0	3.6	16.5	20.1
Lake	4.7	4.3	51.8	12.4	2.3	2.2	4.3	.5	27.1	19.4	46.5
Central	2.6	7.0	11.4	30.1	2.9	3.0	7.8	.8	24.7	40.9	65.6
South	11.6	17.4	15.8	77.7	7.3	7.3	16.0	1.8	86.7	104.2	190.9
Pacific Coast	3.9	1.1	13.9	4.1	1.4	1.4	4.3	.5	23.5	7.1	30.6
North Rocky Mountain	.2	0	1.2	.1	0	0	0	0	1.4	.1	1.5
South Rocky Mountain	0	0	0	0	0	0	1.3	.1	1.3	.1	1.4
Total	24.5	37.8	97.8	145.4	15.5	15.6	34.3	3.8	172.1	202.6	374.7

Similarly, 11.2 million acres now in private ownership under extensive forestry are needed in the budget of which 85 percent are assumed will remain in that category. This gives 9.5 million acres remaining in private ownership, and 1.7 million acres which must be acquired by the public. The same process was followed for all the other regions. For the areas requiring merely protection, it was assumed that for the favorable lands about 50 percent will remain in private status and 50 percent in public. For the unfavorable areas, 10 percent was assigned to private and 90 percent to public ownership.

The data in table 10 as far as they allocate probable future ownership of lands must be considered only as an approximation and on the assumption that private ownership will be far more affirmatively interested in continuous timber management than it has in the past. Even in the most favorable regions, the present acreage either under intensive or crude forestry is inconsequential when the total allocated in the budget for private endeavor is considered.

Forestry by private owners under this plan would require the following distribution of the total of 202.6 million acres: 37.8 million acres in intensive forestry; 145.4 million acres in extensive forestry;

15.6 million acres under protection on lands favorable for forestry; 3.8 million acres under protection on lands unfavorable for forestry.

Table 11 indicates the regional distribution of the 172.1 million acres of present private land apparently destined for public ownership, plus the area now available in public ownership. Public acquisition of this 172.1 million acres would require the following selection of land by kind of management: 24.5 million acres suitable for intensive forestry; 97.8 million acres suitable for extensive forestry; 15.5 million acres favorable to forestry for protection; 34.3 million acres unfavorable to forestry for protection.

TABLE 11.—*Total area destined for public ownership for timber production*

[Values given in millions of acres]

Region	Area now available [1]	Additional area from private ownership	Total area
New England	1.4	3.8	5.2
Middle Atlantic	2.0	3.6	5.6
Lake States	4.7	27.1	31.8
Central States	.7	24.7	25.4
South	3.2	86.7	89.9
Pacific coast	23.0	23.5	46.5
North Rocky Mountain	23.5	1.4	24.9
South Rocky Mountain	26.1	1.3	27.4
Total	84.6	172.1	256.7

[1] Other lands now in public ownership are so located, or lack the kind and amounts of timber stands, that they cannot be considered as a factor in timber production.

In determining how far the public must go in acquiring and managing forest land the following facts must be given careful consideration:

1. The total forest growing stock in the Nation is insufficient to maintain a supply equal to present consumption of timber.
2. The regions where the most favorable opportunities for private forestry exist have depleted growing stock, and cannot produce a reasonable quota of the Nation's timber needs, unless a combination of intensive and extensive forestry is applied to a large part of the commercial timber areas.
3. The regions with a considerable surplus in growing stock are those only moderately favorable for private forestry.

Obviously, if this seriously depleted growing stock is not built up, a progressive reduction in timber supply must be expected. This question has, of course, an important bearing on the amount of forest and abandoned agricultural land that should be placed in public ownership. The public has too much at stake to leave the result to accidental fruition, or to the possibility that a shortage of stumpage and high lumber prices will attract private enterprise to keep pace with national timber needs. The safer and sounder policy, and as a first step, is to place at least the 172.1 million acres in public ownership, and under proper management withthe assumption that private owners will handle 202.6 million acres. Even on lands where private forestry can be practiced profitably, but where no private interest for doing it exists, it will be good national economy to extend public forests immediately.

The evidence indicates strongly that public forestry on an enormously increased scale is needed in the Southern, Central, and Lake

States regions, where growing stocks are most seriously depleted. These regions are counted on to contribute ultimately a great share of our timber requirements.

But even in the Pacific region, showing an abundant surplus of growing stock, failure to treat forests properly, applying at least extensive forestry methods, will bring large parts of this region, as the virgin stands are cut, into the same critical forest conditions existing in the older regions of the East. This justifies extension of public forests in the West, particularly to protect the present surplus of growing stock, and secondly, because private enterprise on the whole is largely disinterested in a long-term timber management business.

Public ownership of watershed and recreational areas is an established procedure for many States and the Federal Government. Public acquisition of forest lands chiefly for timber production has likewise been established as a Federal venture. Heretofore Federal acquisition has been planned to create relatively small and well-managed units to serve as demonstration areas, rather than to handle large areas of forest land chiefly valuable for timber production. The situation now calls for strong emphasis on large-scale timber production, particularly as the wastage of forest values has been accelerated during the process of private ownership breakdown. Through public ownership existing values can be safeguarded and built up. The ultimate public cost will in the long run be far less if action for public acquisition is initiated at once and on a large scale commensurate with the task ahead.

FEDERAL ACQUISITION OF PRIVATE STUMPAGE AS A MEANS OF PROLONGING EXISTING TIMBER SUPPLIES

A section of this report ("Public Acquisition of Private Lands as an Aid to Private Forestry") shows in detail the justification for Federal acquisition of stumpage as a means of stabilizing the timber industries and local communities.

In the States of the north Rocky Mountain and Pacific regions it was shown that an excessive volume of merchantable stumpage is in private hands, that the accumulated carrying costs on it have forced many properties to go on an operating basis in order to obtain current income, that the installed mill capacity and the annual output of lumber both exceed normal consumptive demands. The excess production forces drastic cutthroat competition, both within the two regions and with other lumber-producing regions, and compels high grading of the best species, trees and logs. Thus large quantities of intrinsically useful material are necessarily left unused and the total drain on the timber supplies is chronically far in excess of the material needed and used.

The statement referred to indicated that there still remain in the northern Rockies and Pacific regions a number of nonoperating timber properties, but that the owners are under very heavy financial pressure to liquidate. Additional operations would obviously make an already critical overproduction situation worse, both in terms of industrial and local economic distress, and in wastage of intrinsically useful timber supplies.

The analysis of available supplies of stumpage and the rate at which new growth is taking place shows clearly the urgent need to husband the stocks of already grown timber that we now have. About 636 billion board feet out of the total saw-timber stand of 1,668 billion is in private ownership in the northern Rockies and Pacific regions. Of this, about 242 billion board feet (excluding farm woodlots except in California and inferior species such as larch and fir) are in accessibility zones 2 and 3, that is, so located that no profit can be made in operating the stumpage, on the basis of average operating costs and selling prices. Despite this fact, new operations continue to be begun in these zones, because of the unendurable financial pressure which forces stumpage owners to risk any gamble in order to obtain some current income.

An analysis of other possible means of controlling the installation of new operations ended with the conclusion that the surest way to curb further overproduction was for the Federal Government to acquire substantial volumes of saw timber on nonoperating properties. Such a program would enable the Federal Government as stumpage owner to offer for cutting the acquired stumpage along with existing national-forest stumpage as it was actually needed. This plan of management would be simply a continuation of established policies. If new and large operations could be prevented for even a few years, as this program would prevent them, old operations would continue to drop out, as stumpage supplies were used up, and a reasonable balance between production and consumption demands would become established.

In this way, too, new operations could be organized on a sustained-yield basis, that is, cutting only the amount each year that could be replaced through regrowth. Plan-wise utilization such as this is an established part of national-forest operations, and avoids the worst consequences of the over-rapid liquidation now characteristic of lumber operations on private lands.

Even a moderate slowing down of the rate of removal of the private stumpage of the Northwest would prolong markedly the period during which it will be available. Moreover, the more stable industrial conditions which could be brought about through balancing production and consumption would make it profitable to utilize large quantities of wood which is not used when cut-throat competition prevails.

The more orderly utilization would have the further desirable effect of maintaining growing stocks. Stumpage in the East has been liquidated under private ownership to a point where the growing stock is only about 40 percent adequate. Too rapid rate of cutting and lack of attention to keeping the cut-over land productive have resulted in the job now on hand.

Exactly the same process is now going on in the West on private forest lands. The increased Federal ownership would surely prevent an unnecessary reduction in growing stock, but one which is inevitable unless present western trends are halted.

The need for maintaining growing stock, for husbanding available supplies, and for augmenting them in effect by more complete utilization is so clear that whatever feasible method will accomplish these purposes is worthy of adoption.

Federal purchase of about 90 billion feet of private stumpage in zones 2 and 3 would have such an effect. It is estimated that the purchase price would be about $100,000,000. By withholding the stumpage from sale until actually needed, this sum plus carrying charges would certainly be returned to the Federal Treasury. In the long run the project would at least pay for itself.

The public acquisition program recommended as necessary to carry the public's share of balancing the timber budget therefore includes saw-timber areas, as well as areas on which timber below merchantable size is now growing and areas which must be restocked. A balanced public program necessitates prolonging to the utmost the supplies now available, besides growing future supplies. Both projects are covered in this program.

PUBLIC OWNERSHIP AND WATERSHED PROTECTION

EXTENT AND DISTRIBUTION OF WATERSHED AREAS

The protective value of forests to watersheds is summarized for the major regions in table 12. Of the total of 244 million acres of commercial and noncommercial forest land east of the Great Plains exerting a major or moderate influence on watersheds something over two thirds or 171 million acres has a major watershed value and nearly 10 million acres is in public ownership. West of the Plains 137 million out of 205 million acres possess major watershed value, and nearly 120 million acres are publicly owned.

PRESENT OWNERSHIP

The forest land with major or moderate watershed value under public ownership is 69.4 percent of all such land in the West and but 4.5 percent east of the Plains. The total of 296.8 million acres of privately owned forest land possessing watershed value are a potential field for eventual public acquisition, to the extent that private ownership does not now promise to protect the watershed values, or as future needs develop. This statement does not, of course, mean that any such plan is recommended as a program. It means simply that where private ownership fails to conserve public values, the public may have to acquire the lands to protect itself. Thus, obviously, the estimation of the immediate or eventual area which the public should acquire can only be based on an appraisal of the existing condition of watershed lands, existing methods of treatment by private owners, and probable trends in use and treatment.

TABLE 12.—*Present ownership of commercial and noncommercial forest land having major and moderate watershed protection value*

[Values given in millions of acres]

Region	Total forest area commercial and noncommercial with major watershed value	With major and moderate value	Total area with major and moderate watershed value now publicly owned and managed	Public domain	Private forest area commercial and noncommercial with major and moderate watershed value
New England	10.9	21.3	0.9	----------	20.4
Middle Atlantic	17.2	25.1	4.5	----------	20.6
Lake	3.9	6.1	.3	----------	5.8
Central	39.5	52.0	1.0	----------	51.0
South	99.8	139.7	3.4	----------	136.3
Total East	171.3	244.2	10.1	----------	234.1
Pacific Coast	56.2	75.3	36.5	2.0	36.8
North Rocky Mountain	17.7	40.6	31.6	1.2	7.8
South Rocky Mountain	62.8	88.7	52.0	18.6	18.1
Total West	136.7	204.6	120.1	21.8	62.7
Grand total	308.0	448.8	130.2	[1] 21.8	296.8

[1] Exclusive of 0.9 that is not segregated from other public lands in the eastern regions.

In addition to the forest land, fully 50 million acres of the abandoned farm land previously referred to is estimated to lie within the watershed influence zones. The detailed reports on watersheds designate many regions where a principal watershed protection problem centers in revegetation and conservative management of abandoned farm lands. This acreage, therefore, is to a high degree a potential field for public acquisition, since such land is seldom attractive to private owners.

DEGREE TO WHICH PRIVATE OWNERSHIP IS CONSERVING WATERSHED VALUES

The studies of the Nation's watersheds recommend on the basis of present conditions, the acquisition by the public east of the Plains of 92.4 million acres of private commercial and noncommercial forest land. These figures approximate the desirable program to meet urgent public needs as they are appraised today. The suggested acreage includes only major-influence land that is not being managed, or that according to all indications will not be managed, in a manner reasonably satisfactory from the point of view of watershed protection. In the Northeast, where watershed values are in general substantially protected on lands in private ownership, only the most critical areas are recommended for acquisition; in the South, where little progress has been made on private lands even in fire protection, a much larger proportion of the major-influence land is included. Only 133,400,000 acres of forest land (commercial and noncommercial) out of a total of 202 million acres of private land having major watershed value is suggested as the public acquisition program. None of the 95 million acres having moderate influence or of the 148 million acres having slight to no influence has been recommended for acquisition for watershed protection. Of the 444,357,000 acres of privately owned forest land only 30 percent has been included in the suggested acquisition program. According to repeated indications in the watershed reports, unless existing practices are checked or modified, this estimate may need to be greatly enlarged in the not distant future.

The details of the suggested public acquisition programs by States and regions are summarized in table 13. The total of 114,200,000 acres for the watersheds east of the Plains, large as it is, includes only lands of major influence on which public interest clearly will not be met by private ownership. The watershed reports indicate repeatedly that existing practices, unless checked or modified, may add largely to this total in the not distant future.

These figures are necessarily approximations, and would undoubtedly be modified by more detailed field examinations. But they serve to focus attention on the very large area on which public acquisition and management of forest units is needed at once. Quite evidently, the cumulative effect of many decades of unplanned land use has created a very large immediate problem, and one in which public acquisition must be prepared to undertake programs far more extensive than those previously considered.

TABLE 13.—*Areas of privately owned forest and abandoned agricultural land of major influence on watersheds suggested for public acquisition in the 5 eastern regions*

[Values given in millions of acres]

Region	Commercial forest	Noncommercial forest	Agricultural land	Total
New England	3.6	0.2	0.4	4.2
Middle Atlantic	4.8	.4	1.0	6.2
South	42.0	10.2	11.7	63.9
Central	26.1	3.0	8.2	37.3
Lake	2.0	.1	.5	2.6
Total	78.5	13.9	21.8	114.2

The study of watersheds in its broad conclusion, therefore, still depends on private ownership to safeguard watershed values on more than half of the eastern watershed areas. This situation may look differently at some relatively near time in the future, when treatment of private lands may have changed significantly, or when the cumulative effect of bad agricultural practices may have become fully operative. Such a situation appears to exist in southern Illinois where several million acres of formerly farmed land is in process of going out of agricultural use and is eroding.

As already brought out, continuing or permanent private ownership of forest lands depends on the opportunity for making a profit from forestry, and this varies greatly from region to region. A large part of the most critical watershed areas are on the headwaters of streams, where the conditions for successful private ownership are often less favorable than the average for the general region. Dependence on private ownership to conserve watershed values on important areas to the degree indicated will certainly not be justified unless a timber-production program of the magnitude outlined in this section is made effective.

It should again be emphasized that these are only approximate areas of major watershed importance, on which private ownership has most markedly failed to conserve the public values, and where, therefore, public ownership appears as the most effective solution. Detailed field examinations are needed as a basis of definite plans for public acquisition. Other considerations than condition of land necessarily have a bearing on the feasibility of public ownership as a remedy for depreciating watersheds.

LIMITING FACTORS IN ESTABLISHING PUBLIC PROTECTION FORESTS

Public watershed protection forests, in order to accomplish their primary purpose, necessarily must bring into public ownership a reasonable proportion of the total hill land within their boundaries. On a mountain slope, for example, if 10 percent were acquired and well managed while the remaining 90 percent remained in bad condition, or was subjected to destructive practices, the effect of the public ownership on the watershed as a whole would be relatively slight. Quite probably the public effort would not be justified, since the same expenditures made in an area where a higher percentage of land could be acquired and managed, would pay larger dividends in watershed protection.

Public agencies engaged in acquiring forest units for watershed protection need to know in advance about what proportion of the total area needing protection can be acquired at reasonable unit costs. The acquisition of land for forest is limited in the main to woodlands, either those on farms or in other ownership, and to farm land which has been abandoned for farming purposes, or is used merely as wild or uncultivated pasture. With few exceptions, hill farms in active use for crop land or cultivated pasture, are unavailable for public purchase, simply because unit prices are generally very materially higher than for other classes of land.

The reports on major watersheds recite numerous areas in which erosion brought on by cultivation of slopes is not only ruining the soils for agricultural cropping, but is contributing in a serious degree to irregular run-off and silting of rivers. The problem of sloping lands actively used for agriculture is not, however, to any significant degree one susceptible of immediate solution through forestry. As hill lands become seriously eroded through the practice of unwise agriculture, they tend to drop out of any but the most extensive agricultural use, and come within the price range of public agencies. The basic principle in public acquisition for watershed protection necessarily has to be, in general, to acquire the greatest number of acres having high watershed value, rather than to acquire particular areas.

In analyzing particular watershed areas as possible purchase units, any public agency must, therefore, reckon the lands potentially obtainable as including only the three classes mentioned. No definite and fixed percentage of ownership within a unit can well be set as marking the minimum public holding which would accomplish watershed protection to the degree justifying a long-continued public project. The higher the probable percentage of acquisition, the better. A few of the western national forests contain only about 40 percent of public land, and yet are effective in accomplishing the public purposes for which they were established. Administration of such forest units, though complicated by the alienations, is feasible. Units of smaller size, such as parts of ranger districts, commonly have 25 percent only of public land.

It seems reasonable to use 35 percent of potentially obtainable land as the limit below which public acquisition of lands for watershed protection would rarely go. This guide is simply an approximation, useful in analyzing the opportunities for public forestry in some of the major drainages of the eastern and central forest regions.

Experience to date with public forests shows that the beneficial effects are not confined to the lands actually in public ownership. The systematic fire control on public forests is necessarily extended to intermingled private lands, so that in this respect the entire area within a public forest is usually treated as a unit. Where grazing of domestic livestock is a use of the public lands, cooperative arrangements are gradually worked out so that conservative grazing on private as well as public lands is brought about.

A further factor limiting the initiation of public acquisition programs is that units need to be of fair size before economical and effectve administration is possible. A lone unit containing say 50,000 acres would require a resident forest officer to protect it against trespass and fire, and handle current business. If a part-time employee was used, the effectiveness of public ownership might readily be lessened. No inflexible guide can be set up, but in most cases units containing less than 100,000 acres of potentially obtainable land should be of noteworthy importance and value to justify consideration as public purchase units for watershed protection. However, in cases where intensive management for forest production, or outstanding demonstration value or recreational value will be combined with watershed protection value, the minimum size of units can often be materially lower than 100,000 acres.

In several of the Central States, relatively narrow bands of badly eroding land along the main rivers offer a problem not previously met in public forest acquisition in this country. The area of land in each unit would be relatively small, and new problems of administration would develop. Nevertheless, the urgency of stabilizing these "breaks" is so high that some form of public acquisition and management is clearly needed.

THE OBJECTIVE OF PUBLIC FOREST ACQUISITION

The principle that within public purchase units, not less than 35 percent of the total watershed value land should eventually be acquired, applies with the greatest force to the plans of public agencies for the individual major watersheds. If a given river has on its watershed say 30 million acres of land which is depreciating under private ownership, the highest possible type of public management on one or two or three million acres can hardly stabilize the watershed as a whole. In considering a given unit, the public is not justified in going in at all unless it can expect to acquire a major holding. If the field for eventual public ownership is sharply limited, public entrance is probably unwarranted.

The same consideration applies in the consideration of watersheds of individual streams. Either public ownership should contemplate an eventual large share in the total area needing protection, or it should keep out. The objective of watershed protection is to stabilize the stream as a whole, and is not primarily to stabilize particular areas of land.

The early concept was that a few public forests on the headwaters of major streams would do the job of watershed stabilization. Experience on the western watersheds shows unmistakably that all of the land on a watershed must be given proper treatment, or the beneficial effects obtained on 50 or 60 percent of the land will be seriously depreciated. The lower areas are, in several cases, partly nullifying the effectiveness of national forests on headwaters. The exceedingly critical erosion on the "breaks" of the Mississippi, Ohio, and Missouri Rivers is by no stretch of the imagination a "headwaters" problem. All or a very high proportion of the land in a drainage basin as a whole must be recognized as the field for planned and conservative land management.

Clearly the greater the public values at stake, the greater the urgency for public acquisition and management. Where public funds have been or are to be invested in constructing reservoirs or in improving navigation, unrestricted silting due to erosion within the watershed, will obviously shorten the life of the public improvements, and wipe out some of the capital investment. Protection of watersheds having such costly public improvements automatically assumes a high priority. The reports of the major watersheds indicate the location of the high value projects.

EXTENT AND LOCATION OF WATERSHED AREAS FEASIBLE FOR PUBLIC OWNERSHIP

In table 14 are summarized by regions the total acreage of forest and already abandoned agricultural land which is in units such as have been suggested as feasible for public ownership. The figures were derived in the following manner:

For each county indicated by the watershed studies as having major or moderate watershed importance, the acreage of woodland on farms, woodland in other ownership, and farm land abandoned for cropping were combined to give a total figure. This is the area potentially obtainable for public forests, as explained previously. The percentage of the total area of the county which the potentially obtainable land makes up was then calculated, and each county was thus classified as having less than 20 percent potentially available land, from 20 percent to 34.9 percent, from 35 percent to 49.9 percent, from 50 percent to 64.9 percent, and over 65 percent.

The diagram maps then made it possible to determine the location of groups of countries having 35 percent or over of potentially obtainable land, and thus to block out units of not less than 100,000 acres. The process was applied to the States in the South, Central, and Lake regions where the individual watershed reports indicated particularly critical problems of watershed protection.

Not all of the potentially obtainable land can be regarded as actually available within the price range of public purchase. Some owners of forest land, for example mining companies, do not figure their property as timber land but as mineral land. So long as the minerals are being extracted the property is not on the market.

A certain amount of woodland within the units is attached to farms which will remain in cultivation. Where the farm land and woodland on an individual farm are intermingled, the owner would be little interested in selling the woods only.

In table 14, a reduction of the "potentially available" figures has been made to give recognition to the fact that certain individual owners of forest land are likely to hold their properties. The estimate of "actually available" land, which is recommended for eventual public purchase, is necessarily an approximation. The amount of land finally obtainable in a given unit can be determined only after many years. This analysis indicates that in the Central States region feasible public ownership units totalling 44.1 million acres of potentially obtainable land might be blocked out. The great bulk of this lies within the major influence zone. In the Southern States the total area is 73.3 million acres, and in the Lake States 3.1 million acres, both almost wholly within the major influence zones. Even these very large areas are not estimated to take care of all the watershed areas or existing problems in the regions mentioned. They would, however, take care of major value areas with important immediate problems.

Most of the recommended units in these regions would be entirely new, that is not tied into existing public forests. Most of the States in the Central and Southern regions have no forest acquisition program and national-forest purchase areas already established cover only a small fraction of the total area within which public acquisition is both needed and feasible.

In the New England and Middle Atlantic regions many of the States have already established forests and parks as well as programs for additional acquisition. The analyses of opportunity for public forest units have therefore not been made for these regions.

In the West, an area of 21,800,000 acres of public domain has high or moderate watershed value, but is not managed. Placing of this area under management by adding it to existing national forests has been already recommended as feasible, and since the lands are depreciating seriously through lack of management, this would be the greatest single step in solving the watershed problems of the West.

Studies of the private forest lands of the western regions indicate that of the 62,700,000 acres having high or moderate watershed value, some 41 million acres are within or adjacent to existing national forests, or are in blocks of feasible size to justify public acquisition. Extension of national forest boundaries for the purpose of allowing acquisition of private lands has already placed a large area of such lands within the reach of existing public acquisition programs.

PUBLIC AREAS RECOMMENDED FOR WATERSHED PROTECTION

Table 14 indicates the recommended ultimate public acquisition for watershed protection for each of the major regions. In the South the total estimate of 64 million acres is in units in which 50 percent or more of the land is potentially obtainable, and is with few exceptions in mountain and piedmont plateau areas classified as having major watershed value. The units which might be blocked out are generally large and none are less than 200,000 acres.

In the Central States, most of the estimated total of 37.3 million acres is in units in which more than 50 percent of the land is potentially obtainable, though a few units in Illinois, Indiana, Ohio, and Kentucky have 35 to 50 percent only. Local studies, particularly in Illinois, indicate that the amount of agricultural abandonment as reported in the last census are very much lower than they will be within a few years. The units now estimated to contain 35 to 50 percent of obtainable land will probably have a much higher percentage of such land within a short time. The area recommended for public acquisition includes units to take care of the "breaks" along the main rivers.

In the Lake States the area in Wisconsin classified as having major watershed value and within which an area of 2.6 million acres is recommended for public forest acquisition, mostly in units containing 35 to 50 percent of obtainable land. In the New England and Middle Atlantic regions the recommended additional public forest areas of 4.2 million acres and 6.1 million acres, respectively, take account of programs already under way. In the western region, the recommended program will bring into public ownership about two thirds of the private forest land with important watershed protection value.

TABLE 14.—*Private forest land areas recommended for eventual public ownership for watershed protection*

Region	Private forest land in units feasible for public purchase	Area abandoned agricultural land in units	Total private land potentially available in units	Total private estimated as actually available and recommended for public ownership	Commercial forest in recommended units
New England		0.4		4.2	3.6
Middle Atlantic		1.0		6.1	4.7
Lake	2.6	.5	3.1	2.6	2.0
Central	35.9	8.2	44.1	37.3	26.6
South	61.6	11.7	73.3	64.0	41.6
Total, East	100.1	21.8	120.5	114.2	78.5
Pacific Coast				22.6	17.5
North Rocky Mountain				6.2	5.2
South Rocky Mountain				12.2	3.8
Total, West				41.0	26.5
Grand total	100.1	21.8	120.5	155.2	105.0

These regional recommendations totalling 114.2 million acres east of the plains and 41 million in the West are necessarily approximations. Only a very large additional amount of detailed field work could make it possible to assert that the figures are accurate. As has been said previously, existing situations, existing needs, and existing and probable future trends in land use have had to be appraised in a very broad manner in working out the recommended program. But the approximations do not obscure the fact that the needed public forest for watershed protection of important areas in the East total many times the old concepts and the existing programs of the States and the Federal Government. The ultimate area of State forests in all of the States east of the Plains, after full effect has been given to present policies, will be not much over 5¼ million acres of major watershed forests and fully four fifths of this will be in the Middle Atlantic region, chiefly in New York and Pennsylvania. The national-forest programs as approved up to June 30, 1932, by the National Forest Reservation Commission contemplates the purchase of 5,171,000 acres, which will bring the total national-forest area in the East, managed primarily for watershed protection, up to approximately 10 million acres. This area, equivalent to 5.6 percent of the major-value area of the East, will have required about 45 years to acquire if the rate of acquisition to date continues.

Including lands already acquired, the existing State and Federal programs combined will finally total only slightly over 22.5 million acres, spread over 244 million acres of major and moderate watershed-value land. Whether the recommended areas for public acquisition are too high or too low is not the primary concern. It is, rather, that we recognize the very large problem of watershed stabilization, particularly in the East, and the fact that private-ownership practices and unplanned land use have created the problem; and that we accept the fact that the public agencies must acquire areas far greater than has generally been thought necessary.

The program of public-forest acquisition, even if carried out promptly, will not in itself solve the whole of the watershed problem. Either the practices of agriculture on hill lands will have to be modified, or agriculture will have to be given up, if the problems of erosion are to be fully solved. Forestry can not be a means of halting erosion on plowed lands.

THE MULTIPLE-USE FOREST PROGRAM RECOMMENDED FOR PUBLIC OWNERSHIP

PRACTICABILITY OF MULTIPLE-PURPOSE PRINCIPLE

The need for publicly-owned and managed forests has been dealt with as they apply to the protection of watersheds, the conservation of recreational areas, and the building up of continuous and permanent sources for timber crops. In arriving at final estimates of the areas which should be placed under public ownership, fulfilling these three major purposes, the possibllities of multiple services have been carefully weighed. Generally, and with regard to the major portions of the proposed public forests, it will not be necessary nor desirable to segregate and dedicate certain areas for timber cropping, other areas solely as watershed units, and still others as recreational units. A sikllfully managed forest can serve all these purposes at the same time. But there will be instances where management will necessarily be devoted to one dominant use, whether it be timber cropping, watershed protection, or recreation.

In the earlier part of this discussion independent estimates were made for the additional public forest needed to meet our timber, watershed, and recreational requirements. Thus it was estimated that 133.4 million acres were required for watershed, 172.1 million acres for timber, and 21 million acres for recreation. In the light of the possibility of multiple use, it is necessary to determine how far the areas in these three categories overlap.

REGIONAL RECOMMENDATIONS FOR MULTIPLE-USE ACQUISITIONS

Three classes of land now in private ownership have been considered as available—commercial forests, noncommercial forests, and abandoned agricultural lands that can be devoted to forestry.

In table 15 the adjustments in areas between uses has been attempted. Under the heading "Net total acquisition" the first column gives the net total commercial forests now in private ownership which should be placed under public management. This figure has been adjusted to meet the needs for all contemplated uses. Similarly the next column gives the area of noncommercial forests needed under public ownership, and the third the area of abandoned agricultural lands. All three recommendations are totaled in the last column. The adjustments and the detailed calculations made are as follows:

New England region.—The 3.6 million commercial forests needed for watersheds will take care of the 3.5 million acres set up for timber growth; the 0.4 million acres of agricultural land needed for watersheds will be sufficient to take care of the 0.3 million acres required for timber; the 3.6 million acres set aside for timber and watersheds will be insufficient for recreational needs, so that 2.3 million acres will have to be added; the noncommercial areas remain unchanged. Thus, the total needed is 5.9 million acres of commercial forests, 0.2 million acres noncommercial, and 0.4 million acres abandoned agricultural lands.

TABLE 15.—*Ultimate public acquisition program for all forms of land use*

[Values in millions of acres]

Region	Timber acquisition			Watershed acquisition				Recreation	Net total acquisition			
	Commercial	Agricultural	Total	Commercial	Noncommercial	Agricultural	Total		Commercial	Noncommercial	Agricultural	Grand total
New England	3.5	0.3	3.8	3.6	0.2	0.4	4.2	5.9	5.9	0.2	0.4	6.5
Middle Atlantic	1.1	2.5	3.6	4.7	.4	1.0	6.1	5.9	5.9	.4	1.0	7.3
Lake	21.6	5.5	27.1	2.0	.1	.5	2.6	1.4	21.6	.1	5.5	27.2
Central	19.7	5.0	24.7	26.6	2.5	8.2	37.3	2.4	26.6	2.5	8.2	37.3
South	70.0	16.7	86.7	41.6	10.7	11.7	64.0	2.5	70.0	10.7	16.7	97.4
Pacific Coast	23.5	0	23.5	17.5	5.1	------	22.6	1.8	23.5	5.1	------	28.6
North Rocky Mountain	1.4	0	1.4	5.2	1.0	------	6.2	.7	5.2	1.0	------	6.2
South Rocky Mountain	1.3	0	1.3	3.8	8.4	------	12.2	.4	3.8	8.4	------	12.2
Total	142.1	30.1	172.1	105.0	28.4	21.8	155.2	21.0	162.5	28.4	31.8	222.7

Middle Atlantic region.—The 4.7 million acres of commercial forest needed for watersheds in his region is more than sufficient to take care of the 1.1 million acres needed for timber requirements, but insufficient to cover the amount set up for recreation by 1.2 million acres. The 1.0 million acres of agricultural lands needed for watershed plus the 4.7 million acres of commercial forest lands will entirely meet the needs for timber growth set up for the region. Thus, 5.9 million acres of commercial forest, the 0.4 million acres of noncommercial forest, and 1.0 million acres of agricultural lands, will be sufficient for timber, watersheds, and recreation.

Lake region.—In the more detailed study of ownership made in the watershed section, it was shown that in the forested region the ratio of commercial forest land to abandoned agricultural land in the Lake States is in the ratio of 4 to 1, that is, the abandoned agricultural land makes up 20 percent of the total area in large blocks of land. Therefore, it is assumed that 5.5 million acres of agricultural land is available for timber growth. The areas in the commercial and agricultural categories, therefore, overlap comfortably the areas shown as needed in the same categories under watersheds and recreation. The total, therefore, needed for the region is 21.6 million acres of commercial, 0.5 million acres noncommercial, and 5.5 million acres of abandoned agricultural land.

Central region.—In this region the areas required for watersheds are sufficient to meet the needs of both timber growth and recreation and hence these values appear as the total of the region.

South region.—In the South the intermingled agricultural abandoned land available for forestry is approximately 20 percent of the forested land. Thus, the area set up as needed for timber, being greater in both commercial and agricultural areas, can in these classes be made coincindent with the watershed and recreational areas, excepting for the 10.7 million acres in the noncommercial category. The total, therefore, needed in public forests are 70 commercial, 10.7 noncommercial, and 16.7 abandoned agricultural lands.

Pacific Coast region.—In this region the areas needed for watershed and recreation in the commercial forest class are less than the area of the same class which must be devoted for timber production. Therefore, the 23.5 million acres under timber needs can in part be placed in the watershed and recreational areas. To arrive at the estimate of total public forests, the 5.1 noncommercial under watersheds is added to the 23.5 million acres of commercial timber forests.

North and South Rocky Mountain regions.—In both these regions the commercial forest areas required for watersheds are sufficiently large to take care of the timber and recreational needs. No agricultural land is involved. Therefore, the total public forests is identical with the amounts set up for watershed forests.

These estimates, totaling 223 million acres, form the recommended program for eventual public forest acquisition. Large as they are, and much as they exceed existing official programs of the State and the Federal Governments, they nevertheless are conservative in the following respects:

1. The estimates for public watershed-protection forests do not include many of the forest areas of moderate influence now in private ownership.
2. The areas recommended for watershed protection are assumed to be used for timber cropping. In many cases especially light cutting will have to be used, and in some cases no cutting can be permitted because it would disturb the stability of the protection.
3. The recreational use, with few exceptions, is assumed to be filled by areas managed for watershed protection or timber production, or both. In some areas this will not be feasible, because of intensive recreational use.
4. Reliance has been placed on private ownership to carry well over half of the total job of systematic timber production. This is vastly in excess of the proportion now being produced on the private forest lands as a whole.

The public program recommended is the minimum that can meet the public share of the known needs for watershed protection, timber production, and recreational use.

THE PROBABLE DISTRIBUTION OF FOREST-LAND OWNERSHIP BETWEEN PUBLIC AGENCIES

As has already been brought out, State forests in the West have been created from grants of Federal land, but in State forest programs depending on purchase, the major control of State forest-land ownership is financial ability. Unquestionably there are material differences in various States in prevailing public recognition of forest problems. There is very much more active interest in some States than in others. But an analysis of existing effort in all phases of forestry (see earlier discussions of Federal aid) indicates conclusively that financial ability is the dominant factor, particularly as to what is likely to be done in the future.

There are many ways of rating wealth. Clearly the financial ability of States to go ahead on programs of State forest acquisition will involve consideration of at least the following factors and their interrelation: Total wealth, spending power, acres of private forest land, population.

Table 16 shows by regional groups of forest States the significant figures useful in considering the size of the forest problem and the financial capacity of the State. The regional ratings, which are entirely relative, are also shown.

TABLE 16.—*Relative financial capacity of State groups to manage forest lands*

Region	Wealth in relation to private forest land				Population in relation to area			
	Total wealth (1922)	Area private forest land [1]	Wealth per acre		Total population, 1930	Total area	Population per square mile	
			Actual	Rating			Actual	Rating
	Million dollars	*Million acres*	*Dollars*		*Thousands*	*1,000 sq. mile*	*Number*	
New England	24, 414	19. 6	1, 246	2	8, 166	61. 9	132	1
Middle Atlantic	82, 280	15. 5	5, 308	1	28, 131	111. 9	251	1
Lake	27, 819	34. 8	799	3	11, 026	263. 8	42	3
Central	67, 344	31. 3	2, 152	1	30, 577	363. 0	84	2
South	47, 895	129. 4	370	4	28, 541	760. 5	38	3
Pacific Coast	23, 574	27. 9	845	3	8, 194	318. 1	26	3
North Rocky Mountain	3, 777	5. 9	640	4	983	229. 5	4	4
South Rocky Mountain	7, 907	5. 1	1, 550	2	3, 412	706. 4	5	4
Total and average	285, 010	[2] 269. 5	1, 020		[2] 119, 030	[2] 2, 815. 1		

Region	Private forest per capita		Net retail sales to United States average net [3]		Average of all ratings
	Area	Rating	Ratio	Rating	
	Acres		*Percent*		
New England	2. 40	2	108	1	1
Middle Atlantic	. 55	1	111	1	1
Lake	3. 16	3	106	1	2
Central	1. 02	1	90	3	2
South	4. 53	4	61	4	4
Pacific Coast	3. 40	3	127	1	3
North Rocky Mountain	6. 00	4	100	2	4
South Rocky Mountain	1. 49	2	101	2	2

[1] Commercial, other than farm woodlands.
[2] Exclusive of Kansas, Nebraska, and the District of Columbia.
[3] Editor and Publisher, Nov. 28, 1931.

Relative ratings of wealth per acre and private forest land per capita agree in detail, and the relationships are particularly significant. The average ratings in the last column have been used in estimating relative present ability of State groups to acquire and manage State forests.

DISTRIBUTION

Leaving aside the relatively inconsiderable ownership of forest lands by the smaller political subdivisions, the bulk of the future publicly owned forests will be divided between the States and the Federal Government. The proportion can be approximated by answering the questions. How much will the several States be able to own and manage? and How much, therefore, will the Federal Government have to own and manage?

Table 16 makes possible a broad classification of relative wealth of the States by forest regions. There are of course differences in rating of individual States within a forest region, and the predominant rating has been adopted for each region.

In some of the wealthiest States an active State program or forest-land acquisition is under way. In these there is every reason to believe that the bulk of the additional public acquisition will be handled by the States. But in nearly all, there are areas of watersheds on interstate streams, the ownership of which is a Federal responsibility. On the average, probably 20 percent of the total land acquired will be by the Federal Government and 80 percent by the States.

In the least wealthy group of States it is clearly not to be expected that the States themselves will be financially able to own and manage a large proportion of the acreage. But selected areas, including those having great local recreational and other public values, will presumably be acquired and managed by the States. On the average, therefore, in these groups of States probably 20 percent of the total public acquisition will be by the States.

Two intermediate grades of State financial ability are recognized in which it is estimated that 40 and 60 percent of the total public acquisition will be by the States.

On the basis of these percentages, an estimate of the division of the public acquisition job between the States and the Federal Government is given in table 17. In round numbers, the State share is 89 million acres, and that of the Federal Government 134 million acres. Clearly this is an approximation, but one based on results to date, current trends, and known differences in financial ability between different States and regions.

TABLE 17.—*Probable future distribution of additional public forests between States and Federal Government*

Region	Total public acquisition	Estimated State acquisition		Estimated Federal acquisition	
		Percent	Million acres	Percent	Million acres
	Million acres				
New England	6.5	80	5.2	20	1.3
Middle Atlantic	7.3	80	5.8	20	1.5
Lake	27.2	60	16.3	40	10.9
Central	37.3	60	22.4	40	14.9
South	97.4	20	19.5	80	77.9
Eastern regions	(176)		(69)		(107)
Pacific Coast	28.6	40	11.4	60	17.2
North Rocky Mountain	6.2	20	1.2	80	5.0
South Rocky Mountain	12.2	60	7.3	40	4.9
Western regions	(47)		(20)		(27)
All regions	(223)		(89)		(134)

The foregoing estimates of the eventual size of State and national forests go far beyond the existing official acquisition programs. The area of State forest will be increased by 8,374,000 acres when present State policies and plans are fully worked out (table 2).

Responsible officials in many of the States have prepared estimates of the ultimate area they regard as a suitable objective for an adequate State forest policy. These estimates total 51,419,000 acres, a figure of the same order of magnitude as the estimates worked out in this report. It is clearly desirable that these tentative State plans go ahead as rapidly as possible.

The present plans for national forest additions total 10,977,000 acres in the East and 18,500,000 in the West, or 29,477,000 acres altogether.

The total job of public forest acquisition and management that lies ahead is so large on any basis of estimation, that exactness in apportioning it between the States and the Federal Government is hardly necessary. What is important is recognition that there is abundant opportunity and need for participation by both, that the function of the Federal Government is to supplement State programs, rather than supplant them, and that agreements regarding the sphere of each agency, and carrying out of noncompetitive programs, depend on acceptance of the public forest undertaking as a partnership.

THE COST OF THE PUBLIC ACQUISITION PROGRAM

Estimates of the probable cost of the acquisition program as here recommended must also be approximations, even though a very large amount of experience has accumulated in the national-forest purchase work to date. But average prices paid heretofore for given classes of land are almost certain to be reduced in future public acquisition work, because going prices of wild land are substantially lower than formerly.

The average price to date per acre for 4,727,000 acres of land acquired in the East for national forest purposes has been $4.49. The estimated cost per acre for 7,640,000 acres yet to be purchased in already established national-forest units in the East is $4.05. When the trend thus indicated is taken into account in estimating future per-acre prices for different classes of land in each major region in the East, over the period of time involved in the purchase of the 176,000,000 acres of public area to be acquired, the total expenditure is reckoned at $572,000,000, or an average of $3.25 per acre. This is approximately two thirds the average cost of purchases made to date, and takes account of lands which are likely to come to the public through donations and tax delinquency. Needless to say, the price paid will vary widely between regions and for different classes of land within a single region.

In the West, similar estimates for the 47 million acres of public acquisition area total $75,700,000 or $1.60 per acre average. This estimate likewise takes account of probable donations, tax delinquency, and reduced going prices.

The 90 billion board feet of stumpage recommended for Federal purchase in the West in order to prolong the existing supplies of stumpage are estimated to cost $100,000,000.

The total capital investment of the entire recommended public acquisition program, State and Federal, is thus $748,000,000. Unless going prices change radically during the period of public acquisition, this sum should be sufficient to acquire the forest properties which have been indicated as needed in public ownership.

Of this total sum, the Federal acquisition program, as set forth in table 17 would cost $347,800,000 in the East, and in the West $100,000,000 for stumpage, and $43,450,000 for land, a total of $491,250,000.

The cost to the States, on the basis of division already outlined, is thus approximately $250,000,000.

A SUGGESTED IMMEDIATE FEDERAL AND STATE PROGRAM

The recommended Federal program for purchase of forest and abandoned agricultural land and stumpage may and should be spread out over a period of years.

The major urgent considerations justifying a large immediate program are:

1. Most of the areas which should eventually be acquired are depreciating seriously now. Prompt purchase and administration are needed to begin the often difficult process of rehabilitation. This is true equally of watershed and timber-production areas.
2. The stumpage to be purchased should be acquired in the near future, or much of it is likely to go on an operating basis, and the opportunity for stabilizing its utilization will be lost.
3. Enormous areas of land and stumpage are obtainable at very reasonable prices, and it is obviously in the public interest to take advantage of these without delay.
4. The prompt initiation of the purchase programs would release frozen assets and put money into circulation, and with no question of the worthwhileness of the public expenditures.
5. Once acquired by the public, the forests, particularly in the East, would give a very desirable outlet for emergency employment of labor on the large job of improvements that would be required to develop and improve the forest property.
6. Acquisition programs of the Federal Government and of many States are already on a going-concern basis, and could readily be expanded many times. A rapid expansion could be made without loss of effectiveness or of economical purchase at fair prices.

The total program should be carried out on a 20-year basis or an average of 5 percent a year, for land acquisition, and a 10-year basis for stumpage acquisition. A slower rate of progress would clearly fail to meet both the urgent needs and the opportunities that exist. A very much higher rate of speed would go beyond the present capacity to expand effectively. In round figures, this would mean an annual capital investment by the Federal Government of $30,000,000 for both land acquisition in the East and West, and stumpage acquisition in the West. Of this an average of $18,000 000 would be for eastern and $12,000,000 for western purchase.

At the same rate of increase the annual cost for the State forest programs suggested would be 12.5 million dollars. Clearly this rate is exceedingly desirable. The current financial situations of many States, like that of the Federal Government, involves recognition of sharp reductions in the income obtained from taxes, and this fact is forcing a more or less comprehensive reappraisal of both State and Federal projects, of the means of financing public undertakings, and of the possibilities of reducing public expenditures in general. It seems altogether probable that in Federal financial managment a clear-cut distinction may be drawn between true current expense and capital investment. Land acquisition is clearly a capital investment; its management is largely a current expense.

As State finances are reexamined and reoriented from this standpoint, the place of land-acquisition programs may well be even more favorable than they are today.

SUMMARY

That major shifts of forest land from private to public ownership are imminent is shown by the fact that tax delinquency is already widespread. Farm woodlands, acquired as an incidental part of farm properties, naturally are abandoned when farming is given up, and this has occurred on more than 50 million acres. Other forest properties, acquired for their immediately exploitable timber values, must be reappraised by the owner when his income depends on long-term timber growing, rather than short-time exploitation. The public must be prepared to take over large areas of forest land as private ownership withdraws from management or ownership.

For the National Government and many of the States public ownership and management of forest lands is already established in law, in public opinion, and in fact. Public ownership has more and more supplanted the alternative methods of "laissez faire," public aid, or public regulation. In general, it appears that these other methods are less certain of desired results than is public ownership.

Public ownership of forest lands for watershed protection, timber production, recreation, and wild life is already well established, as a means to protect public values when private ownership cannot or will not do so.

The basis for division of ownership between State and Federal Government is not clear-cut. Some of the wealthy States have State forests of the same kinds of lands and for the same purposes as the national forests. Less wealthy States have done little or nothing in forest-land ownership, regardless of needs or opportunities. Financial ability of the States is the best guide to what part of the public ownership job each is likely to do, and therefore as to the remaining part which the Federal Government must do, if it is done at all.

An analysis of the opportunity for private forestry by major regions indicates that perhaps 85 percent of the forest land is likely to stay in private ownership in the most favorable regions and perhaps not over 10 percent in the least favorable. It is estimated that out of the 270 million acres of other than farm woodland, about 115 million acres (84 in the East and 31 in the West) is likely to become a public-ownership problem because of lack of private opportunity. Even the most liberal public aid in fire control has not kept unattractive lands in private ownership.

Existing formal plans of the States and the Federal Government contemplate eventual total public acquisition of not over 13 million acres by the former and 30 million acres by the latter. This is very much less than the area which seems unlikely to be retained and managed by private ownership.

The Nation's watersheds contain 449 million acres of forest land of high and medium value in the control of run-off and erosion. The watershed studies show widespread, and in many regions critical, depreciation of the watershed lands. A great deal of abandoned agricultural land as well as forest land enters into the problem which forestry is called upon to solve. The conclusion is reached that to a very high degree private ownership has failed to conserve watershed values and that public ownership will be needed to do so.

Public ownership for watershed protection cannot be very effective unless at least 35 percent of the total area within a given unit is within the price range for public purchase. Detailed analyses indicate a total area of 155 million acres of high and medium value watershed area, in feasible units, which is recommended for public purchase and management. This very large program would still leave to private ownership a major part of the forest land possessing watershed value. In the West a large part of the whole problem can be solved by adding to the national forests an area of about 22 million acres of federally owned public domain, which is not now administered to conserve its watershed values.

The needs of the Nation for management of forest lands for timber production total 509 million acres. After taking full account of the part existing public forests may take in balancing the timber budget, and after depending on private ownership to the full extent justified by the analysis of private opportunity, the conclusion is reachod that public ownership of 172 million additional acres of timber-producing land is needed. A regional program of public acquisition to that amount is recommended. The part that reforestation of abandoned agricultural lands will take in the public acquisition programs for timber production and watershed protection is estimated.

Existing tracts of saw timber are seriously deficient and should be husbanded. But in the West, where a very large part of the total stock is in private ownership, too rapid exploitation is under way, because of the financial pressure on owners of nonoperating stumpage, which forces them to go on an operating basis. Federal acquisition of not less than 90 billion board feet of such stumpage is recommended as the surest way to prolong the life of existing supplies, through bringing about a reasonable balance between production and consumption. Such a program is a vital part of the whole program for balancing the timber budget.

A regional summary of the public acquisition needed for all forms of land use indicates the total eventual program as 223 million acres—of which 176 million are in the East and 47 million in the West. The probable division of responsibility between the States and the Federal Government is estimated on the basis that the most wealthy States will be able and willing to take care of 80 percent of the full program and the least wealthy only 20 percent. The remaining areas will necessarily fall to the Federal Government if the job is to be done at all.

About 40 percent, or 89 million acres, of the total acreage is estimated as the State share and about 60 per cent, or 134 million acres, as the Federal share.

The cost of the total public acquisition program, including saw timber, is estimated at $750,000,000. Of this, 500 million is to carry out the Federal Government's share and 250 million the States' share.

The immediate program recommended for the Federal Government is $30,000,000 a year, estimated to take care of 5 percent a year of the total acquisition program or 6.7 million acres of land annually over a 20-year period. This would also purchase annually about 9 billion feet of stumpage over a 10-year period. This rate of acquisition is both needed and feasible. A corresponding rate for the estimated State share would require $12,500,000 a year.

OWNERSHIP RESPONSIBILITIES, COSTS, AND RETURNS

By E. I. KOTOK, Director, California Forest Experiment Station; EVAN W. KELLEY, Regional Forester, Northern Rocky Mountain Region; C. F. EVANS, District Forest Inspector, Division of State Cooperation, Branch of Public Relations; and BURT P. KIRKLAND, Principal Forest Economist

CONTENTS

	Page
Responsibilities of forest-land ownership	1303
National-forest costs	1305
Elements of cost and reasons for needed increase	1308
Summary of needed increases for present areas	1313
Segregation of capital-investment and current-charge increases	1314
Cost of management and protection on new national-forest units	1316
State forest costs	1318
Costs of private forest management	1319
The possible returns from managed forest lands	1320
Sources of returns from forest properties	1320
Returns from Federal forests	1323
Returns from State and local forests	1326
Returns from private forestry	1327
Summary of costs and returns	1328

RESPONSIBILITIES OF FOREST LAND OWNERSHIP

Forests, whether in public or private ownership, are a basic resource. Their treatment involves long-time national interests, and ownership must be considered to imply a responsible stewardship. No State or nation can prosper for long if it continues to deplete its forest and agricultural land resources. No matter how rich it may be in man power or mechanical ingenuity, a country which fails to maintain or to increase its output of the organic products from land must inevitably decline in prosperity or become more and more dependent on other countries for such prime necessities as food, clothing, and shelter. Continued productivity of the land. therefore, is essential to the general welfare.

Generally speaking, the land, as a source of wealth, must last as long as mankind remains on earth. A so-called owner, whether he be an individual, a corporation, or a public body, is only a temporary tenant. His ownership is on an altogether different basis from the ownership of commodities, which can practically always be replaced at will. His use or misuse of the land affects a wide circle of society, in many ways. It may also profoundly affect the welfare of posterity. Future generations have the same right as our own to receive their land heritage with its productive capacity unimpaired.

Land ownership, then, must be considered as a trust for the benefit of both the living and those who come after them. An owner may be entitled to make the fullest use of all the varied products of his land, but society may properly expect that its own interests in land productivity should not be reduced or destroyed. This is as true of forest land—which has very little prospect of being used productively for any other purpose than forestry—as it is of land producing annual crops. The ownership of forest land carries with it an obligation to use the land productively, if society needs the products. If there is no immediate need for them, an owner is under an obligaton at least not to abuse the forest, but to leave it capable of yielding its products and services as soon as a need for them arises.

To use forest land wisely it must be developed. To hold it without developing it is to derive less than the full measure of service which it is capable of yielding. Development requires the expenditure of labor and money. Within reasonable limits, increases in expenditures for forestry can be expected to more than pay for themselves in increased returns. As in Europe in normal times, the largest net returns will be derived from those forests which are the most intensively managed.

Expenditures for the development of local transportation systems, if prudently made, will be more than repaid through the increased value of the timber and other resources thus opened up, as well as in the reduction of fire losses and costs of fighting fire. Silvicultural measures, such as the removal of diseased, misshapen, or otherwise inferior trees, thinning of crowded stands, and measures for reducing or preventing the ravages of insects or disease, will result in more valuable crops of timber. Planting up of denuded spaces in the forest, or replacement of inferior kinds of trees with better ones, will increase the yields in quantity as well as in quality and value. Expenditures for the development and administration of forage resources of the forest will not only be returned through increased receipts from grazing but they will help to prevent damage to the vegetative cover that might result in erosion and undesirable acceleration of stream flow. Investments in the development of game and recreation resources, if they do not bring in a direct cash return, will more than pay for themselves in increased public enjoyment of the forests. When the economic liabilities and social losses in unproductive lands are considered on the one hand, as against present and potential returns from well-managed forests on the other, the essential costs for proper management appear as a relatively low investment.

Forest-land management entails capital and current expenditures for some or all of the following:

1. Resource management of timber, forage, water, recreational values, and wild life.
2. Improvement of property through capital investments and current outlay.
3. Protection against fire, insects, tree diseases, trespass by man and animals, and poisonous weeds.

The attempt to arrive at prevailing and future costs of managing and protecting forest land discloses insufficient data on other than Federal forests. Detailed costs are available for the national forests covering a 20-year period, but only fragmentary data for forests in State and private ownership. For this reason the national-forest costs have been analyzed in detail. These costs may reasonably be assumed to represent costs on other large forest holdings where similar protection and management are to be applied. Also, existing national forests and proposed extensions constitute a large public enterprise warranting special analysis of present and proposed expenditures and appropriations.

The present costs given for national forests represent the costs of current forest practice sufficient to keep these lands productive and prepared for increasingly intensive management; the proposed costs approximate a higher standard of forestry practice than this, such as would produce something like a full timber crop.

NATIONAL-FOREST COSTS

The Federal Government in its management of the national forests recognizes the obligation of stewardship for these forest areas. Congress specifically establishes this responsibility in the act of 1897 which states:

> To improve and protect the forest—for the purpose of maintaining favorable conditions of water flows and to furnish a continuous supply of timber for the use and necessities of citizens of the United States.

Secretary Wilson announced the same principle in his policy letter to the Chief Forester of February 1, 1905, which states:

> In the administration of the forest reserves [called national forests since 1907], all land is to be devoted to its most productive use for the permanent good of the whole people. You will see to it that water, wood, and forage of the reserves are conserved and wisely used. * * *

In the following discussion the costs for managing and developing the national forests are considered on the broad principles laid down by Congress and Secretary Wilson for Federal responsibility in its assumption of responsible stewardship of these lands.

National ownership and management of forest lands must generally provide for multiple use wherein all the renewable resources are developed, improved, and utilized simultaneously. This form of management requires expenditures for all the major factors of cost enumerated above. Private ownership, on the other hand, more often has only a single purpose in the management of a forest property and needs to provide funds for the development and utilization of only one resource.

The national forests embrace about 161 million acres of land in 31 of the States and the Territory of Alaska. For the purposes of the present discussion the small area in Puerto Rico is omitted. These forests contain a variety of forest and related resources in different stages of development and of marketable value. They require treatment different in both character and intensity. The proper development of these resources significantly affects broad national interests, although tied in with local and regional needs. Because of these broad national aspects, all the national forests together may properly be considered as a single enterprise for the purpose of calculating both the costs and benefits of management, although a great spread in cost may exist between different units.

The simplest way in analyzing the items of cost and in making broad comparisons between present and proposed expenditures is to reduce all costs to a unit basis, the acre. This method has therefore been followed. In table 1 are shown, by major activities, the present and probable future per-acre costs for managing and developing the 161 million acres of national forests.

TABLE 1.—*Average costs per acre of the protection and management of the national forests, including Alaska*

Activity	Present cost	Estimated future cost
Protection:		
Current administration and capital investment:	*Cents*	*Cents*
Fire[1]	3.374	4.218
Insects	.070	.125
Disease	.172	.193
Timber management:		
Current administration	.720	.856
Capital investment:		
Stand betterment	.084	.954
Planting	.019	.131
Grazing:		
Current administration	.705	.742
Capital investment	.200	.443
Recreation:		
Uses, administration	.178	.184
Wild life, administration	.090	.185
Capital investment	.077	.174
Lands: Administration	.401	.441
Improvements: Capital investment	.865	1.872
Undistributed overhead	.124	.124
Total	7.079	10.642

[1] These fire costs differ from those given in the section, Protection against fire, since the latter are spread over only the 95 million acres of national forests requiring special provision and expenditure for protection, whereas in this table the total costs are spread over the entire national-forest property. Fire costs per acre on only the 95 million acres protected are 5.72 cents for present expenditures and 6.853 cents for proposed.

Programs of different time intervals have been set up for completion of essential capital investments and increases in current expenditures, depending on the resource, the necessity for completing the jobs to prevent losses, trends in prospective resource requirements, and the magnitude of the task. For example, planting work must be planned a long time ahead; the job is big; therefore expenditures have been figured on a 20-year program. Immediate capital investments to hasten better practice where important values are jeopardized are set up in a short 5-year program, whereas large scale improvements have been set up in 10-year programs. The calculations were made as follows:

The usual accounting procedure of segregating current expenditures from capital investment charges was followed. The current costs represent the usual annual recurring expenditures for protection, resource management, and maintenance of existing improvements. They include such items as salaries, wages, and expenses of personnel and labor employed in protection, resource management, and maintenance of improvements, roads, and trails. The total annual current expenditure for any activity divided by 161 million acres, gives the per-acre cost for current administration of that activity for the national forests.

A different procedure was followed in calculating the annual cost per acre for capital investments. The total current expenditure for any capital investment does not represent the annual carrying charge. To arrive at the correct figure, it was first necessary to sum up the total money spent for each capital investment under each activity. The next step was to depreciate or write off the sum expended, converting this figure to a total annual carrying charge. Interest was not included. This total divided by 161 million acres, gives the annual per acre carrying cost for capital investments. The depreciation and write-off periods used were based on the best data available as to the probable life of improvements or the time at which a given cultural job will no longer be repeated on a given area. For example, the construction costs of roads and trails were depreciated in 40 years, giving a 2.5 percent annual carrying charge. In this instance, the rate of depreciation is rather high, because with another charge already included for maintenance, roads may be expected to give service longer than 40 years. Buildings, depending on kind, were depreciated in 15 to 20 years, which gave an annual carrying charge of 6.7 and 5 percent.

Stand betterment, planting, and other cultural operations were written off in a 100-year period, representing the average long rotation likely to be used on the national forests, or at the rate of 1 percent per year. Since in Federal finances an amortization or sinking fund is not usually employed, the write-off and depreciation method was substituted, to ascertain the actual costs of a given activity.

The present and proposed average cost per acre for the existing national-forest system merely represents the average for 161 million acres. Costs for a single national forest unit may vary considerably from this figure, depending on the number of activities administered and the intensity of present management and development. For example, nearly 83 million acres of the 161 million acres in the national forests are grazed by livestock, and if the grazing costs are charged directly to this acreage and not to the entire property, the present per-acre grazing cost is 1.76 cents instead of 0.90 cents. Similarly the total acreage on which timber sales are now made or likely to be carried on during the next 40 years is about 50 million acres or only 31 per cent of the gross area. Present timber-sales cost on the total area is 0.823 cent per acre, but, if based on the 50 million acres, would be 2.650 cents.

The wide spread that may appear between costs for different national forests is illustrated in table 2, where costs for actual acreage covered are given for four typical units representing different combinations of resources. Present costs vary from 6.6 cents per acre in a unit with a predominant grazing resource to 19.3 cents per acre, where heavy utilization is being made of many resources.

TABLE 2.—*Average costs per acre of resource management and fire protection on representative national forests*

Character of use	Activity	Present cost	Estimated future cost
		Cents	*Cents*
Varied multiple use	Resource management	9.653	15.955
	Fire	9.660	10.774
		19.313	26.729
Timber predominating. no grazing business	Resource management	6.033	14.642
	Fire	6.490	7.290
		12.523	21.932
Grazing predominating, no timber business	Resource management	4.953	8.099
	Fire	1.660	1.600
		6.613	9.699
Predominate watershed and recreation, no timber and no grazing business.	Resource management	4.830	6.195
	Fire	7.160	9.483
		11.990	15.678

The timbered forests, where active business is now carried on, have generally the highest cost, both in fire control and resource management, and correspondingly yield the greater revenue. The lower costs are found on the units where grazing is the major resource, and both resource management and fire control require minimum expenditures.

The per-acre costs cited above are based upon the total national-forest area of the United States (Puerto Rico excluded). If the Alaskan forests be excluded, as their alienation from many of the economic and environmental conditions that affects costs in the national forests of the States might warrant, the per-acre costs will be somewhat higher, as shown in table 3. These higher costs are somewhat more appropriate for estimating costs that may be involved in future additions to national forests in the States and for State forests.

TABLE 3.—*Summary of present and proposed expenditures per acre for national forests in 31 States only*

Activity	Present cost	Estimated future cost
	Cents	*Cents*
Protection	4.159	5.215
Timber management	.914	2.205
Grazing	1.034	1.349
Recreation	.408	.564
Lands	.459	.592
Improvements	0.989	2.153
Undistributed overhead	.143	.143
Total	8.106	12.221

ELEMENTS OF COST AND REASONS FOR NEEDED INCREASE

In the management of forest lands as with any other property, a balance must be struck between expenditures and returns. Frequently inadequate expenditures will fail to show any returns while a very slight increase in costs may turn an unprofitable venture into a good paying investment. The maximum returns from forest lands require definite plans for sufficient current expenditures and outlays for capital investment to insure future income. In the administration of the national forests, returns and public benefits are of two kinds—those directly salable and producing revenues and others, as for example watershed protection, which add to the general public welfare but for which no service charges are made. Expenditures on the national forests have been progressively increased in the past few years. Further increases are urgently needed if the property is to be built up to its potential possibilities in returns and public benefits.

The increases in expenditures suggested for the national forests are discussed in some detail, to indicate why such expenditures are warranted in a national enterprise of this character. This discussion, however, may also be helpful in appraising costs that other owners of forest land may have to make to secure maximum returns from forest-land management. The elements of cost for each major activity are therefore briefly summarized.

PROTECTION AGAINST FIRE

The need for increasing the average per-acre expenditure for protection against fire is fully discussed in the section "Protection Against Fire." Briefly, adequate fire control is the first essential step in forestry and, like all other objectives in any positive form of management, will not be reached without providing additional finances. While the fire problem has been successfully met on many national forests which require but little additional expenditures, there still remain 30 million acres in the national forests where the situation is critical and intensified protection effort is of paramount importance. These areas represent the most accessible timber-growing sites, the most valuable watersheds, and the most intensively used recreational forests. On the present scale of protection these areas will retrograde, but adequate funds can reverse the process.

PROTECTION AGAINST INSECTS

Protection against forest insects, as pointed out in other sections of this report, must be provided not only for the normal year but also for the years when attack becomes abnormally high. The proposed expenditure for insect control is raised from 0.07 to 0.125 cent per acre and is largely to be devoted to handling bark-beetle attacks in the most valuable pine stands. A proposed $200,000 annual expenditure doubles the present allotment for this work and will be merely sufficient to hold in check the building up of epidemic attacks in the commercial timber belts of ponderosa, sugar, white, and southern pines, and lodgepole pine on the national forests. Further increases will be needed if the less valuable stands of lodgepole pine are to be protected or if endemic losses in any valuable species are to be entirely curbed. Unusual epidemics are not predictable, but when they do occur, control work must be handled with dispatch. No provision is made in these calculations for the control of abnormally high epidemics of bark beetles or for serious attacks by new insect pests or for insects whose work is only occasionally very destructive. Protection against insects is set up as current annual charge.

PROTECTION AGAINST TREE DISEASES

Few tree fungous diseases are specifically treated in the national forests at present but these are partially controlled as a result of other activities. Disease induced by indigenous fungi generally spreads in a forest stand after a fire and can be partially checked as fires are successfully excluded by adequate protection. Cutting under silvicultural methods and consequent stand betterment remove diseased trees and thus reduce sources of further infection. These costs are included under fire protection and timber management, but do not appear in protection against disease. As sound silvicultural treatment proceeds, each rotation should as a general rule find stands in healthier condition and a checking of disease may be possible. For example, in some of the western virgin stands the first cutting shows averages of 10 to 25 percent cull, while in the second cut the cull will be reduced to only 5 percent.

It is otherwise, however, with exotic fungi. These once transplanted in a new environment, on a new host, may almost completely exterminate a species. And this, in fact, is happening with the chestnut in the East. In the West, the white-pine blister rust, a virulent and destructive disease of the five-needle pines, is reducing the valuable white and sugar pine in both quantity and quality and may eliminate them as a species of commercial importance. Fortunately the blister rust, because of its double host, offers an opportunity to protect the pines through the removal of one host (Ribes). In the light of European experience with intensive forestry, systematic forest management brings on its own disease problems, more or less different from those of our virgin or culled forests, but which will nevertheless require measures of control. These are not provided for in the calculation.

The proposed increase raises the present per-acre expenditure from 0.172 to 0.193 cents (table 1), devoted mainly to the control of the blister rust. A total sum of $2,000,000 a year for 5 years will safeguard the white and sugar pine from extermination but on 3 million acres only. It will leave exposed about 10 million acres on which 5-needle pines make up a small portion of the total stand, and which can be replaced by other species now found in mixture.

The proposed cost has been calculated as follows: The total $10,000,000 needed for eradication is considered as a capital investment to salvage and perpetuate the white and sugar pine on selected and important commercial areas. This sum has been charged off for an entire rotation or at the rate of 1 percent per year, giving an annual carrying charge of $100,000. In addition 7 cents per acre per year will have to be spent on the 3 million acres treated to prevent reinvasion of ribes, which will cost $210,000 per year. Therefore, $310,000 is the annual carrying charge.

TIMBER MANAGEMENT

It is estimated that timber sales will be made on about 50 million acres in the national forests of the United States and this area will require definite silvicultural management for timber production during the next half century, the remaining area for the present needing only to be given adequate protection against fire. Timber management requires a group of technicians to prepare management plans, determine sale policies, administer sales, and carry out silvicultural work and stand betterment. Provision must be made for current jobs as well as for development and preparation for future sales.

The proposed expenditures for current business in timber management are estimated at 0.856 cents per acre, an increase of 0.136 cents over present cost (table 1). This is to take care of the administration of sales of timber, which will progressively increase in amount during the next 20 years. This increase in expenditure need not be made in one step, but annually, as anticipated increased business actually materializes. It is expected to involve finally an increase of $215,000 annually.

Stand betterment is being effected at present largely in the course of regular timber sales. Since the national forests were established, timber sales have been made on about 1,874,000 acres of land on which area betterment and improvement of the stand was possible. In the next 40 years it is estimated that about 8,500,000 acres of national-forest land will probably be cut over, which also will require silvicultural treatment in connection with sales. On national-forest timber sales we start with virgin forests or culled stands which are not producing up to their capacity and the silvicultural task is to increase volume or quality growth in the next rotation. The cost of doing this work is now allowed for in fixing the sale price of the stumpage; no Federal cash expenditures are involved and no appropriations are needed. To show actual costs, these additional expenditures have been included in the calculations and charged off at 1 percent per year, or as a capital investment in the land on a 100-year rotation. Since the cutting on national forests will be materially larger in the future, the cost for stand betterment in the course of selling and cutting stumpage has been likewise increased; but this will not involve any cash outlay, as it will be taken out of the sale price of stumpage.

Many stands not in current timber sales need work that can profitably be done and should be provided for. Thinnings of crowded stands, girdling and removal of weed trees, elimination of hazards and many other cultural improvements have all an important place in forestry. Frequently such cultural operations will pay for themselves currently. In many places, particularly in the eastern forests, outlays for such work, even where no immediate returns are possible, will pay big dividends in increased growth and quality increment of the stand. Practically no expenditures are now incurred for such activity. Recent preliminary estimates of the national forests show that about 2 million acres can immediately be given cultured treatment at an estimated cost of about $4,000,000. Detailed surveys will undoubtedly reveal large additional acreages on which similar cultural operations can profitably be made. This investment, amortized and spread over the entire 161 million acres, would amount to about 0.248 cents per acre, and is considered as a capital investment. In the East such treatment has been already initiated profitably by a number of private timberland owners.

A mere start has been made in planting on the national forests. To bring unproductive lands into use and to provide additional needed growth on sustained-yield units, 2,100,000 acres should be planted during the next 10 or 20 years. The work will cost about $10 per acre on the average, and will involve a total expenditure of about $21,000,000. The cost for this work is charged off at the rate of 1 percent a year, and is considered as capital investment in the land itself. Annual appropriations in the past few years have averaged about $210,000, but to meet present needs five times this schedule is a minimum requirement. The proposed cost per acre will be about 0.131 cents as against 0.019 cents at present, which represents the amortized cost of planting work to date (table 1). This estimate applies solely to existing national forests. Planting costs on possible extensions of national forests is included in a later discussion.

GRAZING

Forage is an important and salable resource on 83 million of the 161 million acres in the national forests. When well regulated and managed, the grazing of domestic livestock makes feasible the harvesting of an annual crop which would otherwise go to waste; it frequently reduces the fire danger by cropping inflammable fuel, and thus lowers the cost of fire control. When properly controlled it adds a fair annual income to a forest property without jeopardizing other values in timber, watersheds, or recreation. This comparatively cheap forage maintains an important industry, adds value to dependent farms and grazing lands outside of the national forests, and is the basis of the production of low-priced beef, mutton, and wool. Present current administration costs are 0.705 cent per acre, spread over the entire national-forest system. An increase of $50,000 is needed annually, making the proposed rate 0.742 cent per acre. This annual increase is particularly needed for additional personnel to perfect and put into operation better range management plans so as to insure progressive improvement of the resource, solve vexing problems existing on many national-forest units, and secure proper utilization consistent with the safeguarding of other resources. In addition, there is urgent need for capital investment for range improvements, so that present range resources in themselves can be permanently safeguarded against abuse and that new areas may be developed for extending the grazing business. Capital investment charges in such range improvements will have to be advanced from 0.2 cent to 0.443 cent per acre. Proposed annual expenditures will provide for the following essentials on the basis of a 10-year program:

1. Range improvements—development of water and fences: $150,000 for capital investments and approximately $30,000 for maintenance.
2. Poisonous plant eradication—initial and follow-up work covering 100,000 acres on badly infested valuable range: $50,000 the first year, up to $500,000 in the tenth year.
3. Rodent control on 5 million acres, where permanent damage will ensue unless action is soon taken—initial and follow-up work: $50,000 in the first year, up to $68,000 in the tenth year.
4. Revegetation of 810,000 acres of depleted ranges, which will require $2,500,000 expenditure in a 20-year program.

RECREATION

In other sections of this report the importance of recreation and the necessity for providing increased facilities have been discussed. In every forest region recreation is becoming a pressing problem, and there is every indication that it will as time passes be greatly aggravated and accentuated. Present per-acre costs are 0.178 cent for general administration, 0.090 cent for wild-life management, and 0.077 cent for capital investment for essential improvements (table 1). The proposed expenditures are but slightly increased, involving costs, respectively, of 0.184, 0.185, and 0.174 cent per acre. In contrast to other activities, recreational use occurs on practically every national forest. The total increases needed for an indefinite period are: For administration, $100,000 annually; for wild-life management, $153,000 annually. For capital investment, a total of $2,250,000 is needed, available at the rate of $450,000 annually for a 5-year period. Estimates for wild-life management presupposes that forest officers will continue to act as agents of the State; but under complete Forest Service management, including intensive control of hunting, the costs would average from 1 to 2 cents more per acre.

LANDS

This activity involves the tasks that go with the acquisition of lands, surveying boundaries, and the management of all commercial special uses. Proposed per-acre costs are 0.04 cent higher than present costs, involving an increase of $64,000 in the annual appropriations for this activity for an indeterminate period. These costs do not provide for additional work under any enlarged program of acquisition. If any plan for extensive purchase of lands for national forests is undertaken, additional appropriations will be needed for the current item considered above.

IMPROVEMENTS

This item includes expenditures for general miscellaneous improvements, development roads, trails, and such parts of forest highway appropriations as are chargeable directly to the development of the national forests. Roads, trails, buildings, telephone lines, pastures, and other physical improvements are the tools for adequate administration, sound development, and proper utilization of the numerous forest resources. Good transportation systems on a national forest will give opportunity for closer administration, for increasing sales of mature timber, for better cultural treatment, and for the better disposal of unused forage and other products or services. Expenditures for stream improvement either to control erosion or to facilitate transportation of forest products are not included.

In the proposed increase over present expenditures for improvements of 1.017 cents per acre, miscellaneous improvements are depreciated at 10 to 20 years and roads and trails at 40 years. Appropriations in the past for the development of roads, trails, miscellaneous improvements, and forest highways have varied considerably in amount, because of special unemployment relief funds made available for these purposes. The program recommended for this work will insure the completion of the essential transportation, communication, and physical improvement systems as far as can now be foreseen. The new annual appropriations recommended are:

Development roads (to continue for 10 years)	$1, 500, 000
Trails (to continue for 10 years)	40, 000
Miscellaneous improvements (to continue for 5 years)	300, 000
Forest highways (to continue for 10 years)	3, 300, 000

Only part of the forest highway expenditures contribute directly to forest development, a part is for community service in the States where the national forests are located.

SUMMARY OF NEEDED INCREASES FOR PRESENT AREAS

A summary of additional needs over and above present appropriations to cover an immediate program for the existing national forests is given below. These appropriations are annual and continuing unless otherwise shown.

Protection:	
Fire—roads and trails (for 10 years)[1]	$3, 700, 000
Improvements (for 5 years)	780, 0000
Man power (progressively from $80,000 in 1933 to $625,000 and to continue at that rate annually)	625, 000
Insects	100, 000
Disease (5-year program)[2]	1, 700, 000

---

[1] Fire roads and trails. The amount is the new annual total recommended.

[2] The amount needed annually is $2,000,000 from which has been deducted an average expenditure of $300,000.

Timber management:	
Current general administration	$215, 000
Stand betterment	1, 000, 000
Planting (20-year program)[3]	840, 000
Grazing management:	
Current general administration	50, 000
Capital investments (10-year program):	
Range improvements [4]	180, 000
Poisonous plant eradication (progressively from $50,000 to $500,000)	500, 000
Rodent control (progressively from $50,000 to $68,000)	68, 000
Artificial reseeding of depleted ranges (20-year program)	125, 000
Recreation:	
Current general administration	100, 000
Capital investment (5-year program)	450, 000
Wild life—current administration	153, 000
Lands: Current general administration	64, 000
Improvements:	
Development roads (10-year program)[5]	1, 500, 000
Trails (10 year program)[5]	40, 000
Miscellaneous improvements (5-year program)	300, 000
Forest highways	3, 300, 000

SEGREGATION OF CAPITAL-INVESTMENT AND CURRENT-CHARGE INCREASES

Forestry, from its very nature as a long-time enterprise, requires heavy initial expenditures in capital investments to put the property into shape for producing continuous and sustained incomes. In timber production, for example, a proper distribution of growing stock must be attained so that continuous cropping can be assured, which can contribute amply towards all current expenditures.

Both the western national forests, which in the main are the remnants left after the best timber both in quality and accessibility had been privately acquired, and the eastern national forests, which are largely made up of culled-over forests, poorly stocked cut-over areas, and only partially productive lands, are producing only a small fraction of their potential capacity in income and in other public benefits. The greater portion of expenditures up to the present time has therefore been devoted to capital investments, for improvements and better protection of these forests. These appropriations, both for capital investment and current administrative needs, have been progressively increased, but they still fall considerably short of what must be spent to bring the property to something approaching its full potential capacity for returns.

In considering costs, it is important, particularly in the initial stages when a forest property is being converted from a poor income producer to a sustained-yield producer, to distinguish between capital investments and current administrative charges. Ordinarily current administration and protection charges will be covered by income even on a poor forest; but expenditures for capital investments must be recognized and accepted as an investment to insure future returns and income.

For the purpose of illustrating and analyzing these two distinct classes of costs, the national-forest appropriations for the fiscal year 1933 have been segregated between capital investments and current charges.

---

[3] The amount needed annual is $1,050,000 from which $210,000 now appropriated has been deducted.

[4] This excludes outlay now made in the form of contributed time by forest officers.

[5] Development roads and trails. The amount here given is the new annual total recommended.

Only the items that apply directly to national forests have been included; items that cover other functional services of the Forest Service, as for example State aid, extension, and general research, have been omitted. The costs broadly segregated are:

Capital investments	$12, 036, 689
Current charges	7, 384, 275
Total	19, 420, 964

This capital investment charge includes an item of $5,905,000 appropriated for forest highways, part of which only is of immediate and direct value to national-forest administration. Forest-highway appropriations are made under special acts of Congress to provide for public travel between communities and towns within or adjacent to the national forests and tying in with transcontinental highway systems. The appropriation in 1933 provides about 4.5 cents per acre for current administration and protection. An analysis of the summary of additional needs on page 1313 in comparison with appropriations for the fiscal year 1933 may illustrate further the differences between current charges and capital investment.

The average annual increases in current charges up to the end of the tenth year as the proposed program is put into effect will consist of the following:

Protection	$725, 000
Timber management	215, 000
Grazing management	50, 000
Recreation management	253, 000
Lands management	64, 000
Total	1, 307, 000

This total, added to the present appropriations of $7,384,275, would give an average annual expenditure for current work of $8,691,275.

To get a better comparison of capital investment as included in the fiscal year 1933 appropriation and the proposed amounts, the forest highway appropriation is excluded, since unlike the other items, it has another special service feature and is not solely a direct expenditure for protection and improvements on the national forests. The fiscal year 1933 appropriations show a capital investment expenditure minus the forest highway item of $6,131,689. The increases needed, exclusive of that for forest highways, is estimated at $4,953,000 for the tenth year, making a proposed total capital investment during that year of $11,084,689. This sum of course will progressively and steadily decrease as each step in the program is completed. After the tenth year the total amount needed for capital investment, excluding forest highways, will be $4,465,000.

Briefly summarized a comparison of present and proposed appropriations are as follows:

	Fiscal year 1933	Proposed average annual appropriations
Current charges	$7, 384, 275	$8, 691, 275
Capital investment (minus forest highways)	6, 131, 689	11, 084, 689
Forest highways	5, 905, 000	[1] 3, 300, 000
	19, 420, 964	23, 075, 964

[1] Estimated share of total forest highway appropriation chargeable directly to national forests.

The apparently large increase in capital investment is, in the light of the information given in other sections of the report, well justified, if the national forests are to be brought up to their full productive capacity for future returns and public benefits.

COSTS OF MANAGEMENT AND PROTECTION ON NEW NATIONAL-FOREST UNITS

A program of acquisition has been set up in the section, The Probable Future Distribution of Forest Land Ownership, which provides for the addition of 134.2 million acres to the present national-forest system. Acquisition costs of the land itself are treated elsewhere. Here it is intended only to consider, in brief summary, the costs for management and protection of the new units, excluding outlays for land purchase.

On the basis of present knowledge, it is reasonable to assume that the per-acre cost for management and protection on the new units, after the purchase program is entirely completed, will be approximately identical with the figures recommended for existing national forests. But these costs will not be approached until a 20-year period has passed, when all of the basic investments are completed and protection effort is confined solely to Federal lands. Immediate costs and those for the next 5 years depend on many factors, including the rapidity of acquisition and the concentration of purchase areas. The acquisition program proposes an annual addition to the national forest of 5,355,000 acres in the East and 1,355,000 acres in the West. In the West these additions in the main are already within or reasonably adjacent to existing national forests. This fact has a material bearing on the amount of money which must be immediately expended for protection and administration of new units. Capital investments especially for protection on existing national forests, contribute considerable value to the intermingled and adjacent private lands, which are to be acquired, and hence, in part such investments will not have to be duplicated. The per-acre costs as well as per-acre appropriations for management and protection on proposed western additions will, therefore, immediately more nearly approach those on present established forests.

In the East on the other hand a more difficult problem is presented. Present national forests totaling more than 7 million acres and spread over 19 States form but a fraction of the final national-forest system proposed. Many of the units, particularly those acquired in the first 5 years, will be in new territory, distant from existing forests. The proposed annual purchase of 5,355,000 acres in the East cannot logically be concentrated in a few units. If the total area set up in the acquisition program is to be completed within a 20-year period, even if sizeable purchases can be made, these will have to be spread over many States according to need for meeting whatever exceedingly critical situations of national import may exist. In the first 5 years or so of acquisition the result will undoubtedly be skeletonized national forests, in which Federal ownership will be scattered through and intermingled with a large percentage of privately owned land, later to be acquired. Later acquisition will round out the property and will permit concentration of effort. Until this is done, particularly in eastern purchase units, appropriations must provide for capital investments and fire protection for areas that approximate the final size of the unit rather than for the fraction acquired. This means that if 5 million acres are purchased in one year, protection must be given to an area nearly twice its size, first to safeguard the acquired land from encroaching fires, and then to prevent deterioration of values on land subsequently to be purchased. Likewise capital investments in improvements cannot be confined solely to the lands purchased, but must of necessity go through intermingled and adjacent forest property.

There are other reasons for advancing expenditures for capital investments with great rapidity on new purchase units. Time is an essential factor in the national-forest program. Every acre immediately placed in productive condition, whether for timber growth to build up the national growing stock or for improvement of watershed, will the more promptly return income and public benefits. Delay, on the contrary, does not merely mean a deferred program. In the process of delaying protection and proper management, the forest property which is to come under public management is likely to depreciate and deteriorate from neglect and abuse and the ultimate costs to the public will be correspondingly higher. It is therefore important to provide adequately for expenditures required in capital investments and at least extend protection to the areas surrounding the land already purchased and ultimately to be acquired. Table 4 gives approximately the area which is recommended for acquisition and the appropriations needed for capital investments and current administration for the first 5 years of the acquisition program.

The following method was used in the calculations involved in table 4:

For the East: Capital investments needed are approximately $2 per acre, or for the entire area to be acquired $214,200,000. As explained before, the rate of construction must be planned in excess of the area purchased in any given year. It has been assumed that in the first year 1 percent of the total needed in capital investment will be made, 3 per cent of the total in the second year, 4 percent in the third year, 6 percent in the fourth year, 8 percent the fifth and sixth years, and thereafter at the rate of 10 percent per year until the capital investment needed for the entire plant is completed. Direct current expenditures for protection are estimated at 5 cents an acre, but protection must be applied to about twice the area actually purchased in any one year until the entire acquisition program is completed. Current administration, outside of protection, is estimated at approximately 5.6 cents per acre for the areas actually purchased, with, of course, no allowance for privately owned adjacent areas.

For the West: Capital investment per acre, as has been seen, will not be as large as in the East, amounting to about $1 per acre, or a total of $27,100,000 for the entire acquisition program. In the West it is suggested that appropriations for capital investments be made at the rate of 5 percent of the total the first year, increasing 5 percent each year including the fifth year, 10 percent the sixth and seventh years, and 5 percent the eighth year. Protection in the West need only be applied to the areas actually purchased. The current cost of protection and administration, which need be applied only to the area purchased each year, is estimated at 10 cents per acre.

TABLE 4.—*Cost for first 5 years of maintaining acquisition program, capital investment (exclusive of land), and current expense* [1]

Region and item	First year	Second year	Third year	Fourth year	Fifth year
Eastern purchases:					
Capital investment	[2] $2,142,000	$6,426,000	$8,568,000	$12,852,000	$17,136,000
Current expenses:					
Protection	535,500	1,071,000	1,606,500	2,142,000	2,677,500
Administration	299,880	599,760	899,640	1,199,520	1,499,400
Total	2,977,380	8,096,760	11,074,140	16,193,520	21,312,900
Western purchases:					
Capital investment	1,355,000	2,710,000	4,065,000	5,420,000	6,775,000
Current expenses:					
Protection	67,750	135,500	203,250	271,000	338,750
Administration	67,750	135,500	203,250	271,000	338,750
Total	1,490,500	2,981,000	4,471,500	5,962,000	7,452,500
Total annual expenditures	4,467,880	11,077,760	15,545,640	22,155,520	28,765,400

[1] 5 percent of total area acquired each year. Eastern program, 107,000,000 acres; capital investment, $2 an acre; protection (double acquired area), 5 cents an acre; administration, 5.6 cents per acre acquired. Western program, 27,000,000 acres; capital investment, $1 an acre; protection, 5 cents an acre (land adjacent to national-forest land); administration, 5 cents per acre acquired.

[2] Capital investment includes planting costs.

STATE FOREST COSTS

As more of the States enter into the venture of acquiring forest lands with the purpose in mind of permanent management, they will undoubtedly assume the full obligation of responsible stewardship and the costs that go with it. Otherwise, no particular reason exists for the creation of a State forest system.

No detailed data are available for analysis of present costs of State forests. Their management and development will undoubtedly follow closely those worked out in national-forest experience, where provision is made for the protection, development, and utilization of all the resources as local exigencies dictate. Multiple-purpose management will feature the State forest as it has the national forest, with here and there one resource singled out as dominant—particularly watersheds and recreation. In the case of watershed forests, all other uses may be considered of secondary importance and sometimes restricted or excluded entirely. Where recreational demands are high, some of the State forests (as has already occurred) may be set aside for exclusive use as State parks. But in the main, if multiple-purpose management is skillfully carried out, all of the resources in State forests can be equally utilized or enjoyed.

The public benefits involved in stream-flow regulation or erosion control may not produce direct revenues, but they will promote the economic welfare, and are one of the chief reasons for the creation of State and national forests. Costs for the development and management of public forests, whether in State or national ownership, will probably be about the same, and the costs estimated for the national forests can be applied safely to the State forests. It was estimated in the first part of this section that State forests may reach a total area of approximately 100 million acres—and States must be prepared, if management is to be applied, to spend about 12 cents per acre for protection and administration and to make a total capital investment of $2 per acre. Costs of acquisition will vary and will involve an average expenditure of about $2.75 per acre for all lands to be acquired, including those obtained through tax delinquency.

COSTS OF PRIVATE FOREST MANAGEMENT

Only meager data are available for estimating the costs of handling forest lands held at present in private ownership. Forests in farm woodlands are held incidentally in conjunction with farm land under crops and, excepting for taxes, ordinarily carry no financial burdens. On many farm woods, however, a reasonable expenditure per acre should bring a greater and more continuous return, making the woodland a source of sustaining reveune to the farmer and possibly converting an otherwise unprofitable farm into a profitable venture.

Conscious effort in the direction of a continuous and sustained cropping of timber is made today on only a mere fraction of the total forest land held in private ownership. The great bulk of the privately owned virgin and even second-growth forest, as reported in other sections of this inquiry, is being rapidly exploited under pressure for immediate liquidation. Only in a few favored sections is there sufficient interest among private owners to invest in forest lands as a long-term enterprise. To practice forestry, whether by private or public endeavor, requires immediate and continuous investments if future continuous returns are to be insured. Rapid exploitation or liquidation is incompatible with the long-term rotations demanded in forest management and with the nonrevenue-producing periods which must pass while depreciated areas are converted to productive forests.

The costs that the private owner must consider in any intensive system of forestry are as follows: Taxes, carrying charges, protection (fire, insects, disease), silvicultural practice, stand betterment, planting. In contrast to the public owner, he need make no investment for nonrevenue-producing public benefits such as recreation, although in some parts of the East, where hunting privileges can be leased, costs for game management may be justified.

The possibilities for private ownership and management of forest lands are discussed in other sections of this report. The costs for private forestry must be determined for each property under one individual ownership and general or average figures can be indicative only. Where the convertible cash values on a forest have been largely removed and a long period must expire before current incomes become available, private ownership may not be attracted, even by the prospect of large profits, if too long deferred. On the other hand, where a property produces a steady current income, private enterprise may be attracted to make the necessary investments in silvicultural treatment, fire protection, and capital investments, because the current income can be made to carry expenditures. Some of the more recent logging and milling studies show that what appears at first hand as added expenditures for silvicultural treatment of a forest may be in reality a blessing in disguise. Case after case has been investigated where such treatment not only gives higher current returns but offers the best opportunity for fully and adequately depreciating heavy capital investments.

Illustrative costs for forestry under private ownership are given in table 5. These figures are based on present costs on national forests and other available data but cannot be safely applied to any one individual operation, although they may represent fair averages for very large properties.

TABLE 5.—*Representative costs for intensive private forestry, in cents per acre per year* [1]

Type	Taxes	Other charges	Protection		Timber management			Total
			Fire	Insects and disease	Cutting	Stand betterment	Planting	
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
Spruce-fir hardwood	25	2	2. 5	0. 2	4. 5	13	2. 5	49. 7
Eastern white pine	60	2	5	10	15	17	4	113
Western white pine	40	2	12	11	12	1	3	81
Ponderosa pine (California)	40	2	8. 5	2	10	1	2	65. 5
Longleaf [2]	20	2	7	--------	3	4	1	37
Central hardwoods	25	2	6	--------	3	3	2	41
Douglas fir (Pacific coast)	50	2	8	--------	3	1	1	65

[1] These are generalized costs for forest properties, in which at least half of the stand is assumed in either virgin forests or in merchantable stands. Silvicultural cutting charges, stand betterment, and planting charged off at 1 percent per year—as a capital investment.

[2] Typical second-growth turpentine forest in the South.

THE POSSIBLE RETURNS FROM MANAGED FOREST LANDS

SOURCES OF RETURNS FROM FOREST PROPERTIES

Timber, whether in the virgin forest, or grown as a crop tended by man, has always been considered the principal source of revenue to an owner of forest property. Such secondary crops as turpentine, forage, game, and recreational values, have, however, under favorable conditions, produced greater incomes than the timber crop itself. Indeed in many places the timber has been maintained solely to perpetuate and increase these auxiliary forest values.

Under ideal conditions, and through multiple-use management, all the resources of the forest are husbanded and developed for use and for revenue. Even where the major returns in income must come from the timber crop, the sale of other products often furnishes sufficient funds to pay a great share of the current operating expense. Therefore good forest management must give consideration to all uses as possible sources of revenue and as lightening the burden of carrying a long-time timber crop. In the United States many of these tangible values of forest lands, regardless of ownership, have not been exploited. In some instances, markets have not been sufficiently developed to provide sources of revenue, in other cases unrestricted free public use has been permitted by custom and tradition.

There is, however, another important group of forest values which to date are not marketable and yet which contribute benefits to special groups and the general public. Among these, watershed protection, as it affects water supplies and water power, is the most important. Recreational use of the forest, likewise, is for large parts of the country a nonrevenue-producing resource. If the forest is in public ownership, the general taxpayer pays for these nonrevenue-producing values; and if it is in private ownership, the owner is the public benefactor. The possibility of realizing returns from these less tangible forest values will be considered later on.

Forest properties held especially for timber, either as virgin forest, second growth, or artificially grown stands, have so far in the United States appeared unattractive as sustained revenue producers. One important factor which has contributed to this is the manner in which the markets for timber products have been supplied, mainly from overrapid exploitation of virgin stands rather than from continuous production of organized forest properties. The resulting competitive marketing of the forest capital from the more accessible areas has not only prevented conservative cutting on much of the lands in private ownership, but on public forests has prevented the relatively inaccessible timber from coming into production and has thus deferred financial returns from it.

If a sustained-yield policy of cutting should now be adopted on virtually all private lands, the nation's timber requirements are sufficient to absorb the products from all of the forests which still contain a sufficient growing stock to yield a current cut of timber. If there is delay in the adoption of sustained yield operations by private owners on accessible areas, general application of sustained yield on less accessible private and on public forests will necessarily be delayed until liquidation has been completed on operations which are able to monopolize present markets.

For this reason no very definite estimate can be made of the time when sustained annual yield can be extended on all privately owned forests and all public forests. Probably such action will not be delayed more than 20 to 40 years. Even then the normal annual returns from sustained yield management will come only from those properties endowed with sufficient growing stock. The national forests in the West with large areas of virgin stumpage and young stands resulting from a quarter century of protection should be in full production within 40 years. The existing national forests of the East and those to be acquired in the future will entail a long process of building up the growing stock. State forests will generally lack sufficient growing stock and take still longer to come into production.

Direct experience in continuous-yield forestry in the United States is limited, but data for forecasting rates of forest growth and stumpage values of leading species are reasonably satisfactory for most regions. In table 6 the estimated gross timber returns per acre under intensive and extensive timber management on public forests are obtained by applying stumpage prices based on 1928–1930 experience to the annual rates of timber production. The production rates, which include a budget cut based on growth, are those presented in the section of this report entitled, "Present and Potential Timber Resources." The stumpage rates used are based on numerous regional logging and milling studies as reported on table 4 of the section of this report entitled, "Status and Opportunities of Private Forestry." The assembled data in table 6 show the possible financial returns per acre from intensive and extensive timber culture on public forests.

Since the returns shown in table 6 are based on conservative growth rates and on stumpage prices already attained, the average results are likely to be conservative as applied to operations which will come into full production some years in the future. They also apply immediately to some of the more favorable situations.

TABLE 6.—*Possible gross income from forestry on public forests by regions*

Region and minimum diameter limit of timber	From intensive forestry					From extensive forestry				
	Growth rate per acre	Net sale value saw-timber stumpage [1]	Saw-timber returns	Salvage and culling returns [2]	Total returns per acre	Growth rate per acre	Net sale value saw-timber stumpage [1]	Saw-timber returns	Salvage and culling returns [2]	Total returns per acre
	Ft.b.m.					*Ft.b.m.*				
N. E.—12 inches	307	$6.75	$2.07	$0.50	$2.57	166	$4.50	$0.75	--------	$0.75
M. A.—14 inches	275	6.75	1.86	.50	2.36	185	4.50	.83	--------	.83
Lake—16 inches	268	6.91	1.85	.50	2.35	179	4.60	.82	--------	.82
Central—18 inches	217	6.75	1.46	.50	1.96	140	4.50	.63	--------	.63
South—18 inches	365	7.02	2.56	.50	3.06	257	4.68	1.20	--------	1.20
P. Coast—34 inches	559	4.16	2.33	.50	2.83	213	2.78	.59	--------	.59
N. R. M.—22 inches	348	6.97	2.43	.25	2.68	175	4.64	.81	--------	.81
S. R. M.—22 inches	126	6.97	.88	.13	1.01	79	4.64	.37	--------	.37

[1] Taken from species figures (mostly 1928–29 values) given in section, "Status and Opportunities of Private Forestry" (table 4), with a deduction of 25 percent under intensive management to allow for profits in logging and milling. In determining the possible realization values, interest and risks on the investment were not included in the costs. In the case of New England, Middle Atlantic, and South Rocky Mountain regions the absence of local logging and milling studies necessitated setting up figures based on results under similar conditions elsewhere. The timber under extensive management is more remote and costs more to get out than that under intensive management. The sale value is therefore computed at only 50 percent of the realization values in logging and milling studies on more accessible areas. This allowance also covers profits to private operators. Returns usually will come from saw timber alone.

[2] A usual attribute of intensive forestry is utilization of intermediate returns from thinnings and returns from salvage of timber killed by insects, fire, etc., together with tops of trees cut for saw timber. These items are estimated at one half cord per acre with 50 percent stumpage, except in the South Rocky Mountain region where they are estimated at one eighth cord per acre, and in the North Rocky Mountain region at one fourth cord per acre.

The program of timber growing set up by this report is only sufficient to provide for permanent national timber requirements. The enlarged national forests will provide only about 35 percent and the State forests 15 percent of these requirements. There is great doubt whether the 50 percent left to private forest management will be realized. Under these conditions it is a reasonable assumption that within the period of 20 to 40 years, forests still having growing stock coming into production, may have a ready market for all higher grade forest products and that the estimated returns will be realized. Gross incomes from extensive and intensive timber management are likely to be reasonably comparable whether under private or public management, except that the private lands, being generally the more accessible and of higher quality, will give somewhat higher returns when equally well managed. Furthermore, since public stumpage is sold to private operators, the returns average less than the private operator can obtain through careful cutting operations carried on by himself. Returns other than from timber may vary more with ownership, and are discussed under each type of ownership.

In dealing with privately owned lands where harvesting and manufacture of raw material is normally done by the owners it can be assumed that they receive full realization value. The returns per acre from intensive and extensive private forestry as estimated in table 7 are based on full realization values without deduction for operating profits allowed in national forest stumpage prices.

TABLE 7.—*Estimated gross returns per thousand feet board measure per acre on private forests under intensive and extensive forestry*

Region	From intensive forestry					From extensive forestry				
	Growth rate per acre	Stumpage realization value [1]	Saw-timber returns	Salvage and culling returns [2]	Total returns per acre	Growth rate per acre	Stumpage realization value [1]	Saw-timber returns	Salvage and culling returns [2]	Total returns per acre
	Ft.b.m.					*Ft.b.m.*				
New England	307	$9.00	$2.76	$0.50	$3.26	166	$9.00	$1.49	--------	$1.49
Middle Atlantic	275	9.00	2.48	.50	2.98	185	9.00	1.67	--------	1.67
Lake	268	9.21	2.47	.50	2.97	179	9.21	1.65	--------	1.65
Central	217	9.00	1.95	.50	2.45	140	9.00	1.26	--------	1.26
South	265	9.36	3.42	.50	3.92	257	9.36	2.41	--------	2.41
Pacific Coast	559	5.55	3.10	.50	3.60	213	5.55	1.18	--------	1.18
North Rocky Mountain	348	9.29	3.23	.25	3.48	175	9.29	1.63	--------	1.63
South Rocky Mountain	126	9.29	1.17	.13	1.30	79	9.29	.73	--------	.73

[1] From section "Status and Opportunities of Private Forestry" (table 4).
[2] See table 5, note 2. Under extensive forestry only saw timber returns are included.

RETURNS FROM FEDERAL FORESTS

The gross returns attainable from timber stumpage from Federal forests include the estimated annual returns (reasonably forecast) within a period of 20 to 40 years on forests having growing stock, and within 50 to 80 years on those where the growing stock has to be built up. The variation in economic conditions and the rate at which the various improved practices outlined in this report are put into effect cannot be forecast very far ahead, and thus a precise estimate of how long it will be before full returns are attained cannot be closely made. The major portion of the Federal forest area is subject to multiple use in which many resources are revenue producers, through sale or use. The estimated returns from each type of use are given below under their respective headings.

TIMBER RETURNS

The program of Federal acquisition contemplates adding approximately **134** million acres to the 140 million now in the national forests, excluding Alaska. These 274 million acres will of necessity include enormous areas on which private ownership has destroyed or reduced the growing stock. It will include also lands which experience has shown are economically unadapted to private ownership. These are the major reasons for allocating only about 20 million acres to intensive and 90 million acres to extensive (or "crude") timber management under Federal ownership. When the intensive area has been placed in full utilized production through an adequate growing stock, the gross returns from timber sales may be about $50,000,000 annually. In like manner the 90 million acres under extensive timber management might eventually produce a gross return of some $80,000,000 annually.

Less complete data indicate that an additional 10 million acres under extensive forestry in the Alaska forest might yield a gross return of $4,000,000 annually. This brings the estimated eventual total timber returns under the expanded national-forest system in the continental United States and Alaska to a possible $134,000,000. The speed with which this program is carried out, as well as unpredictable economic conditions and other variable factors, will determine the rate at which such returns can be realized both in time and amount.

RETURNS FROM GRAZING

The forage resource is now more completely used than any other revenue-producing resource on the national forests. Unlike the timber, which for the most part is sold to the highest bidder, the grazing has been so far administered to stabilize the grazing industry, giving preference to the small farmer and grazier. This policy has been justified in numerous localities to preserve the value of small ranch properties dependent for summer forage on the forest ranges. Under the present system and scale of charges the average return for the 5-year period 1925 to 1929, inclusive, was $1,626,388, exclusive of Alaska. The acquisition program when carried out will add materially to these returns. Careful appraisal of ranges on existing national forests indicates that the actual normal commercial value of the forage is far in excess of the present rates charged. The future returns from grazing will be contingent on the economic position which the industry dependent on the national forests may eventually attain and the public policies which may be developed regarding disposal and charges for grazing use. It seems logical to expect an increase in demand for use of these resources as the population increases. Grazing with a fair charge for privileges may yield as much as $4,000,000 annually in the course of time.

SPECIAL USES

These include all present revenues from occupancy of forest lands other than timber and grazing use. The average revenues from 1925 to 1929 were $370,000. These revenues may be expected to show a gradual increase. It is reasonable to assume that within 20 to 40 years they may grow to six times the present income or approximately $2,000,000.

OTHER SOURCES OF REVENUES, NOW USED WITHOUT CHARGES

RECREATIONAL USES

The recreation program proposes a withdrawal of some accessible timber areas from commercial use, and a considerable acreage classed as poor and inaccessible commercial timber forests, and their reservation primarily for recreational use. In addition, a large acreage of noncommercial timberland and nonforested land would be made especially available for recreation, including wild-life conservation. All these areas will require outlay for protection against fire, insects, and disease. The administration and protection of such areas costs considerable sums. To this must be added costs for maintaining and increasing the fish and game supply, development and care of camping sites, and the construction of roads and trails. It has been the policy to make no charge for these services in the past. It is not unreasonable to suppose that eventually consideration must be given to the possibility of offsetting the cost of providing the special facilities required by the recreationist through reasonable charges.

As shown in the section, "The Forest for Recreation" (table 1), the number of visitors to national forests has steadily increased and has reached a figure of 32 million, of whom 24 million are transients. Considering the increased area needed for recreation and which must be provided by further extension of national forests, it is safe to estimate that within 20 years the total number of those using the national forests to hunt, fish, or camp will exceed 5 million annually. The possibility of a license fee of $2.00 for adults hunting, fishing, or camping on national forests would provide an annual revenue of $10,000,000. This sum would provide for the necessary skilled administration demanded by increasing public use. Such a fee is not exorbitant, and may well be considered as a possible source of revenue. There are, however, many obstacles, both in public attitude and in difficulties of administration, which may prevent this principle from being applied in the near future.

WATERSHED RESOURCES

As shown in the section of this report entitled, "Watershed and Related Forest Influences", watersheds maintained with a suitable cover of forest and other vegetative growth render special services to irrigation, domestic water supply, power, and navigation projects. The evidence clearly indicates that large expenditures will be required to improve and thereafter maintain watersheds of immediate benefit to these projects. Under the "benefit theory" for the purpose of providing necessary funds for this work, the possibilities of a tax or fee might be considered. For example, a tax of $1.00 per horsepower of water-power development would eventually provide on the basis of 10 million horsepower of development a return of $10,000,000 per annum. Public policy must of course determine whether such a plan for financing is feasible and in best public interest.

SUMMARY OF POSSIBLE GROSS REVENUE

The revenues from national forests under a program of full development may be summarized as follows:

Revenues at present charged for:	
From 20 million acres intensive timber management	$50, 000, 000
From 90 million acres extensive timber management	80, 000, 000
From extensive management Alaskan forests	4, 000, 000
From grazing management	4, 000, 000
From special uses	2, 000, 000
Total	140, 000, 000
Resources now not subject to charge:	
From recreational uses	10, 000, 000
From water-power revenues	10, 000, 000
Total	20, 000, 000
All possible returns	160, 000, 000

Possibly as much as a forest rotation will be required to build up forest revenues to full possibilities. There are, of course, many justifications that can be advanced for the public's undertaking the development and management of forest lands, the social and economic aspects being paramount. To assume that the expenditures made on public forests will be self-liquidating in the sense that for every dollar spent a dollar's worth of goods will be sold to amortize investments may be neither sound economics nor sound social policy. It is important that expenditures made give returns either in direct income or direct public benefits commensurate with the investment. But this does not in any measure preclude the possibilities of creating sustained incomes from public forests sufficient to cover costs. Public policy now recognizes that timber, forage, and similar direct products or uses should be paid for by the immediate beneficiary. We have not yet established the principle that other services such as water, recreation, etc., which are products of the forest, be likewise paid for in large part by the direct user. This latter source of income is suggested merely as a possible plan of financing the public forest enterprise.

It must be again reiterated that the estimated revenues are based, if the full program is consummated, on forests built up with growing stock capable of a sustained-yield income. The possibilities are that income for current expenses may be reached as early as within 15 to 30 years, but incomes to retire capital investments must in the nature of the enterprise be deferred almost to the end of a tree rotation.

CONTRIBUTION TO THE STATES

Under the existing practice 25 percent of the direct gross revenues from the national forests are returned through the State treasurers to the counties in which the forests are situated. The net return to the Federal Government would therefore be 75 percent of the above gross income.

RETURNS FROM STATE AND LOCAL FORESTS

The section, "Probable Future Distribution of Forest Land Ownership", shows the prospective regional distribution of State and local forests. Out of about 100 million acres in State and local public ownership, the probable portions of the areas which are expected to be under timber management are about 10 million acres under intensive and 35 million acres under extensive management. The acreage costs of State forestry were estimated earlier in this section to be comparable to those for Federal forestry, and it can be likewise assumed that returns will be similar. The aggregate intensive forestry return is estimated on this basis at about $24,000,000; the extensive at $30,000,000; making a total of possibly $54,000,000 from timber production if and when this program is carried out. Owing to the expectation that much State acquisition will arise through tax delinquency of lands which have previously been stripped of their timber, it is to be expected that a long period, often a tree generation, will elapse before productivity can be fully restored. Eventually, however, these areas can be counted on to yield large revenues as well as to perform the important functions of supporting local industry.

On State properties, opportunity to lease grazing rights is the same as on Federal lands, but in those regions where range livestock raising is an important industry, few State forests exist or are expected to be created, and consequently not much return can be expected from this source. States may, however, control important sites for water power, irrigation, and domestic water supplies. In such cases the decision will be whether to obtain a revenue from such development or to grant free public use. No doubt, use of State-owned sites for such purposes can be made a source of revenue. Recreational use of forest properties will be under full State control. Since the States usually control fish and game, whether on private or public lands, they are in a position to collect substantial revenues from fishing and hunting licenses. It would be reasonable to collect a higher license fee where the State controls not only the fish and game but the lands as well on which fishing and hunting is pursued.

Procurement of revenues from all forest uses is most effectively accomplished in States where conservation activities are coordinated. The variety of State policies and practices regarding such uses precludes any accurate forecast of the probable revenues therefrom. It is reasonable, however, to look forward to constantly increasing returns not only from timber but other values existing on forest lands. If a general policy is followed of collecting from beneficiaries of these services, it is conceivable the revenues may grow to as much as $10,000,000 from the anticipated 100 million acres in State ownership. Since the areas are already reasonably suitable for game, fish, and other recreational uses, this revenue is available much earlier than the returns from the timber crop.

RETURNS FROM PRIVATE FORESTRY

The section of this report entitled, "Present and Potential Timber Resources" (table 22) contains an estimate of the areas necessary for operation on a continuous-yield basis in order to provide an adequate national supply of timber. Deduction of the sum of the foregoing Federally and State managed areas from these totals leaves to private operation approximately 40 million acres for intensive and 150 million acres for extensive timber management. This share of the prospective national timber production and the corresponding area allotted to private operation involves a vast expansion of private forestry effort over what is now taking place. Unless expansion takes place the requisite national supplies will fall short as soon as the present liquidation of the private merchantable growing stock approaches completion. Since the present growing stock is far under the quantity necessary to yield full production, a long period of building up growing stock, particularly in the eastern regions, must intervene before full production can be attained.

The respective areas under intensive and extensive forestry in each region multiplied by the gross returns (table 7) shows the estimated gross returns from stumpage production. On this basis the total returns might be as much as $140,000,000 from intensive and $300,000,000 from extensive timber management, a total of $440,000,000. This is a return from growing timber and does not include returns from logging, manufacturing, and other ramifications of the wood-using industries.

The close attention which private owners are able to give to their holdings may result in many returns from uses other than timber. Grazing use in some areas yields a considerable revenue. Since the private forest lands include farm woodlands, the value of grazing per head of stock here reaches the highest level. Undoubtedly the timber returns from the forest are often curtailed by the grazing use, but under proper restrictions it constitutes a legitimate source of revenue. Recreational use of private forests is increasing and where the forests can be protected from trespass, it is beginning to yield actual revenues. If public forests are sufficiently extended to provide adequate public hunting and fishing facilities, it will be possible to relieve private owners of the burden and cost of protection against trespass, fire, and other losses. Under these conditions it should become increasingly profitable for forest owners to build up the game supply and obtain revenues from this source.

Watershed values are generally not of a nature to yield private returns except as private owners may own power sites or in some States riparian rights. These sites and rights constitute on the whole a resource distinct from the forest, as in the case of mineral rights. These and mineral rights on some areas constitute the chief reason for ownership of large forest areas but these revenues have not been considered here.

Revenues from naval stores and minor forest products are large in some localities. There is no very definite basis for estimating all these returns but everything considered it is probable that they amount to $50,000,000 per annum on all the private forests of the United States.

SUMMARY OF COSTS AND RETURNS

The scope of the program outlined in this report is so extensive that no one agency is called upon to carry the entire responsibility. Federal, State, and private agencies must be relied upon to go far beyond their present activities in their respective field. It is urgent that within the next 20 to 40 years the plan, with such modifications as experience proves necessary, should be brought to complete realization. It must be realized, however, that depleted areas cannot be brought back to full production in that time. A period of 50 to 80 years of protection and care will be necessary to restore full production.

From the foregoing conservative estimates of returns from forests handled under methods which will insure high rates of productivity, it may be concluded that the forests of the United States, maintained at a level of productivity sufficient to meet fully the national requirements both for timber and other services should produce a gross return of about $700,000,000. This is in terms of stumpage values, with a partial allowance for recreational, watershed, and other more or less intangible values. It includes no allowance for the great spread of industry dependent on logging, manufacturing, transporting, selling, and utilizing forest products. After the costs are deducted from the gross returns, there remains a net of $400,000,000 to $500,000,000 as an earning on the investment in all forest properties, public and private. This is sufficient to restore and sustain a capitalized value in the neighborhood of $10,000,000,000 for the forest resource. This resource being susceptible to continuous renewal and in fact to continuous upbuilding, is thus visualized as a permanent part of the national assets, supporting as long as the Nation lives its quota of business activity, employment, and the manifold services which no other resource can replace in full.

A PROGRAM FOR DIRECT FEDERAL AND STATE AID

CONTENTS

Page
Principles underlying public aid 1329
Indirect Federal and State aid 1330
Aid in protection against fire 1332
Aid in protection against insects 1336
Federal aid in planting 1336
Federal aid in extension 1337
Costs summarized 1338

PRINCIPLES UNDERLYING PUBLIC AID

Public aid, both Federal and State, to private owners is based in part on the public interest in obtaining the full economic and social benefits from the productive forest.

On the one hand, the public must recognize such factors as the following in granting aid:

In fire protection, the public use of private land, public carelessness with fire, and the fire hazard which is beyond the control of private owners;

In insect and disease protection, the irregular epidemic character and special control methods which may make efforts by individual owners ineffective; and

For some classes of forest research and where many small owners of land are involved, the greater effectiveness of combining efforts and acting through public agencies rather than individually. Advice in forest management, etc., is governed by similar considerations. So also is the production of nursery stock for planting.

On the other hand, private owners must recognize such factors as the following in asking and receiving aid:

That the public has the right to expect commensurate returns from its expenditures—it has, in fact, the right to expect that, in the long run, private owners will in their forest management go beyond what the public actually helps to pay for;

That public aid should not go beyond the point of public interest into the pork-barrel category;

That if costs of aid to the public are too high and the returns through ineffective or limited efforts are too low, it may become better public policy to obtain full control of the land by outright ownership and be in the position to receive direct as well as indirect returns; and

That, in other words, the public interest in trying to keep land in private ownership by means of aid may if net costs become excessive have to give way to the public interest by means of direct ownership.

The following program attempts to recognize these considerations and to balance Federal, State, local, and private ownership interest and obligation in determining what aid public agencies should give.

INDIRECT FEDERAL AND STATE AID

It should be emphasized that, excepting cash income for sale of raw materials, the States derive the same benefits from Federally owned lands as they would from State-owned. Therefore, unless cash returns exceed investment and administrative costs, the State profits more through the Federal activity than it would if the project were conducted by the State with Federal financial assistance. Before presenting a program for carrying out the plans for direct financial aid to States that have been proposed in the several sections of this report, therefore, it is desirable to review briefly the other forms of Federal aid that have been recommended.

Although justified primarily for its contribution to the national interest, the largest of the other forms of aid, present and proposed, is in the national-forest project. It was shown in the section of this report entitled "The National Forests as a Form of Federal Aid to the States" that, during the years 1923–1927, there was a net gain to the States and counties concerned of $10,000,000 a year from present Federal ownership. Without the national-forest system, the States would have had to spend an equal amount for equivalent development and care of the land, or to suffer corresponding depreciation of the land and forego corresponding improvements. It was also shown that the States receive the same indirect social and economic advantages with the land in Federal ownership that they would receive were it in State ownership.

Provision is made in this program for Federal aid to States in the survey and local control phases of insect control. This, if carried out, would very substantially reduce insect epidemics, affecting large areas of forests and spreading over State lines. But when this epidemic condition does exist, it calls for emergency action that cannot be left to the local interest—which may often be a minor one—to take the needed action. Therefore, Federal leadership will often be necessary. In addition to the plan for a cooperative survey and control organization, provision is made for Federal control activities at an annual cost of $700,000 and State activities at a cost of $1,250,000. Both fall within the aid classification.

Control of forest-tree diseases falls into two classes. Control of nonepidemic diseases has so far been approached through the cutting and the marketing of the trees affected. Technical advice would undoubtedly make such action more effective.

Disease epidemics present an entirely different problem. The spread of such diseases as the white pine blister rust, for example, can only be checked by vigorous action on the part of the Federal Government with such assistance as may be administratively obtained from the States and private owners affected. The occurrence of epidemics is so irregular, and the methods of control so different and so highly specialized that a satisfactory cooperative control service offers some difficulties. In any case provision should be made for a Federal-control service, which would be an enlargement of the existing blister rust-control organization. It would be available for control of other epidemics and it would also have advisory functions which should be very helpful in both epidemic and nonepidemic diseases. The annual cost would start at $554,000 and rise to $719,000 at the end of 5 years.

Somewhat similar State services would also be necessary from time to time and in different parts of the country, starting with organizations built up to handle current epidemics. State costs are estimated at $537,000 to be increased to $695,000 at the end of 5 years.

It is also true that the present Federal program of forest research, and the larger one proposed, constitute definite aid and benefit to the States and private owners since the results are available to all and the expenses of similar State programs for comparable results is thereby saved. This is true despite the fact that these programs are limited to work on national and regional problems and are extended to local problems only where Federally owned or managed lands are involved.

Another form of Federal aid that has been tentatively proposed elsewhere in this report (see Federal aid in organizing Forest credit facilities) is the extension of the existing Federal farm-loan system to forest projects.

A plan for Federal and State cooperation in advice in forest management to both farm and industrial forest owners is discussed later. In addition, a recommendation is made for a fund which would be built up to $225,000 for direct expenditures by the Federal Forest Service. This, for example, would permit Federal extension where State cooperation could not be obtained and a material strengthening of this activity.

Still other Federal activities that will aid owners of forest land and accomplish the same results as would direct financial aid to States (were that form of assistance practicable in these activities) are the testing and certification of forest tree seed (see section The reforestation of barren and unproductive land); the existing service by the Weather Bureau in forest fire weather forecasts; and the work in control of predatory animals and injurious rodents by the Bureau of Biological Survey.

Although it is recognized that State action might be stimulated thereby, Federal gifts of funds to the States for the purchase of State forests is not recommended. One reason for this is that the Federal Government will have about all the financial load it can assume if the full plan recommended in this report is carried out. Beyond this, it is believed that it will be a sounder principle for any public agency to undertake the acquisition only of the land which it can subsequently finance. Greater efficiency in expenditures can probably be expected. The poorer States would probably need further aid pending the time when forests acquired became self-sustaining. Aid is not needed by the wealthier States. The wealthier States which will have to furnish the funds might prefer, for acquisition outside of their boundaries, to have Federal rather than State forests because of the possibility of obtaining an accounting. Finally Federal gifts for the acquisition of State forests might soon lead to a demand that the existing national forests be turned over to the States.

Federal aid to the States in the form of loans is not recommended for similar reasons. Uncertainty as to payment makes it possible that loans may actually become gifts.

It is considered highly desirable, and has been so recommended in the several sections of this report, that the States engage in most if not all of the forest-aid activities carried on by the Federal Government. It is anticipated that as the Federal program advances there will be increasing State participation, both through independent State action and through cooperative effort administratively arranged.

Whether the Federal Government shall engage in forestry activities designed to promote the public welfare through the medium of State functioning or through that of direct Federal functioning, or through formal agreements outlined by Congress, or through informal arrangements, depends on the exigencies of different situations. In any case, the objective remains the same. The real question is simply of the best way to get the job done.

It is again emphasized, therefore, that the following suggested program for direct financial aid by the Federal Government to the States and private owners and by the States to private owners includes only the smaller part of the whole program, and covers far from all of the cooperative undertakings that it is expected will be carried on. Neither does the private owners' share, as indicated by the attached tables, indicate all that they will do under the program. In protection against fire, for example, the interested private owner supplies a large share of the protection effort, although that does not appear as a cash expenditure. It cannot, therefore, be accounted for in a cooperative fiscal arrangement, or in a statement of moneys expended.

The sections of this report entitled "Federal Financial and Other Direct Aid to States" and "State Aid to Private Owners and Local Political Units" set forth in considerable detail the accomplishments to date under the Federal and State-aid systems for fire protection, planting, and management of farm woodlands. Similarly, the section entitled "Factors Affecting Federal and State Aid" discusses the several factors that have affected these accomplishments, their relation to each other, and their bearing on past and probable bearing on future progress.

AID IN PROTECTION AGAINST FIRE

The Federal program of financial aid to States and private owners begun in 1911 under the Weeks Act was designed to insure the continuous production of timber on the bulk of forest lands. It was hoped that a Federal contribution equivalent to 25 percent of current national needs for fire protection with an equal amount from the States would lend sufficient encouragement to private owners that they would go forward with plans to retain and manage their forest lands as continuous timber-producing properties.

Sufficient time has not elapsed for full realization of benefits from the act of 1911 and the Clarke-McNary Act of 1924, particularly since Federal appropriations have averaged only about 50 percent of the amount contemplated in the Clarke-McNary Act. In most of the wealthier States, however, fire and other protection measures have been advanced at a rate that indicates a healthy situation as to protection, very largely at State expense. All but one of the forested States have organized fire protection work with some contribution from public funds, but in many of those with relatively large acreages of forest lands the funds so far provided are very far from adequate for the job.

Owners of commercial stands of timber in the Northwest have continued to give a fair degree of protection to these properties with such aid as they have received from the Federal Government and the States. In the remainder of the country private expenditures for organized protection have been small, although there has been some increase in protection effort by individual landowners that does not appear in the record.

All in all the possibilities of attaining in the near future an adequate Nation-wide system of protection do not look promising under the present system of Federal aid. While the aid extended to owners of forest land through public assistance in protection has had an appreciable effect in encouraging them to retain and manage their lands for continuous crops of timber, the total results along this line have not been large. Many other factors have determined and will continue to determine policies of private land ownership and forest culture.

These limitations on its present effectiveness do not make public aid in protection any less desirable or necessary. Pending the installation of other forest management practices by private owners or through acquisition of forest land by public agencies, it is of paramount importance that young and old growth be saved from destruction or serious injury. Granting even that other forestry practices may never be installed, protection should still be provided, since on most of the forest lands it is one of the largest single influences in forest production.

It has, therefore, been the plan in this report to recommend extension of Federal aid to States in financing forestry programs to the full extent that seems practicable under the principles established by the act of 1911, i. e., that Federal funds for State use should be conditioned under ratios that require active State participation and under conditions that insure reasonable returns for moneys expended. After exhausting these possibilities, it has appeared that the Federal interest required a greatly expanded program that could be attacked only under the plan of Federal acquisition, rehabilitation, and research that has been recommended elsewhere in this report.

The program section entitled "Protection Against Fire" defines the protection needs for all forest land now in Federal and also in non-Federal public and private ownership, sets up objectives for future accomplishment, and estimates the funds that will be required to attain these objectives.

Because of the difficulty of making an entirely satisfactory estimate for private and non-Federal public lands in the South and the uncertainty of reaching the full objective set up, an intermediate objective which would more nearly represent the possibility of the next 15 to 20 years was specified. For the entire area of lands of this class it remains to outline a more detailed program for the participation of all agencies concerned.

In the section of this report entitled "The Probable Future Distribution of Forest Land Ownership," recommendations are made for the acquisition by the Federal Government of 134 million acres of forest land now in private ownership and for the acquisition of 90 million acres by the States. Should these recommendations as to Federal purchase be carried out, the size of the job to be accomplished through the direct Federal- and State-aid systems (direct financial assistance to the States and landowners for protection by State agencies) would be reduced accordingly. But public acquisition of a large area of land will necessarily extend over a long period of years, and be subject to a great many delays. One of the most urgent present needs, as has been pointed out above, is to preserve existing stands and to create conditions that will result in the maximum natural restocking and growth and the minimum drain from fire, insects, and disease. Another most important need is the encouragement of cutting practices for the dual purpose of increasing productive capacity of the land and income from it. It is not believed that these needs can be fully satisfied without largely increased public ownership or public regulation, or both, but pending accomplishments through these means it is important at once to extend the necessary protection to all forest lands regardless of ownership.

The system of cooperative protection inaugurated by the Weeks Law of 1911 and expanded by the Clarke-McNary Act of 1924 has in the main worked out well and, as shown by previous sections of this report, great progress has been made under it; but, as also shown, the progress has been unequal in the different sections of the United States.

Obviously, any Federal-aid system which matches State funds on a definite ratio applicable to all of the States will result in a Federal contribution to the better-financed States larger in proportion to total needs than that to the poorer or more backward States. The extreme of this in fire protection is illustrated by a comparison of State and private expenditure in the middle Atlantic and southern regions. In the middle Atlantic region State and private expenditures were in 1932 equivalent to about 90 percent of total average needs; to this was added Federal participation equal to 17 percent of the total current protection expenditures, thus providing funds more than equivalent to the average needs for an adequate system of protection. In the South, State and private expenditures do not exceed 8 percent of the present needs (intermediate objective), and if Federal funds were allotted in the same ratio to actual expenditures as in the Northeast, Federal allotments would in 1932 have equaled only about 3 percent of needs as compared with about 17 percent in the Middle Atlantic States. Thus the large share of Federal appropriations would have been spent in the States best able to take care of their forest lands, and a smaller share in those whose forest acreage consists in large part of cut-over lands which in their present condition are not attractive to private interests and furnish a meager tax base on which the State can raise needed revenues.

The above situation has been in part met in the past by the Federal system of allotting to each State up to 8 or 9 percent of its total needs, provided that it is spending enough annually to match the Federal allotment on a 50-50 basis. Federal funds remaining after this allotment is made are then divided among the States in which fire-protection expenditures go beyond this minimum, in the ratio that their further expenditures bear to the total of all of the States.

Under the policy of limiting assistance to 25 percent of total current costs, the Federal Government has lagged behind rather than led the States and private owners in protection effort. So long as Federal appropriations are held to 25 percent of total actual expenditure, instead of being adjusted on the basis of total needed expenditure, Federal assistance at the higher ratio which some State needs require can only be given by the method of allotting less than 25 percent to other States. On the other hand, if the ratio of Federal to total expenditure were to be increased from 25 to 50 percent or any higher percentage, the result would be, as was pointed out in Factors Affecting

Federal and State Aid, to call for an increased Federal appropriation. For the present at least the same results can be attained through the method of allotting to each State 25 percent of its total needs as fast as the States can match such allotments on a 50-50 ratio. Tables 1 and 2 propose a financial arrangement for putting all forest lands under protection during the next 20 years and are in accordance with this plan.

It is, of course, obvious that such a program would result in a ratio of Federal reimbursement higher in some States than in others for a long time, possibly in some cases permanently. It is also recognized that such a plan would not necessarily result in adequate protection for all forest land in all of the States, because to bring that about the States and private owners would have to provide all of the cost after the halfway mark had been reached. It is a question of recognizing, first, that the rate of reimbursement would be unequal, and, second, that no perfect or perhaps no permanent scheme can be devised at this time.

The situation with reference to State aid to private owners is comparable to that described above, with a wider divergence in the degree of public assistance rendered. In a large percentage of the States protection of forests from fire has been recognized as a public responsibility, the expense of which is met from general taxes. On the other hand, several of the Northwestern States have not recognized the principle of public aid in cost of protecting privately owned forest land but make appropriations for protection of State-owned properties.

The plan here proposed is to continue whatever scheme is in effect in the different States, recognizing, however, that changing conditions of forest cover and economics will affect the amount that landowners can and will pay for protection of their properties, and that, after making allowance for what it is estimated the landowners can pay in those States where they are expected to contribute, and after adding the Federal share, the States must provide the remainder if the job is to be done.

Under the above-described plan, the State share of the total cost varies from 75 percent in those States that have adopted systems of protection wholly at public expense to 35 percent in some States where it is estimated that as much as 40 percent of the total cost can be obtained from the landowners.

In setting up the amount to be obtained from private owners, present State systems of protection have been followed. In those States where the system of State-wide protection is in effect with the public paying the entire cost, no estimate of private expenditure has been included. In States whose systems of protection provide for sharing the cost with the landowners, there has been included an amount which it is estimated private owners would voluntarily contribute if the States extended their protection systems as indicated. Under the system now in effect, and of which the continuance is recommended, the Federal amount remains the same regardless of the source from which the States raise the remainder.

It is, of course, obvious that under any system of Federal aid, which requires the matching of Federal by State funds on a given ratio, progress can be made only at the pace set by the States. It is therefore possible to indicate only the total possible requirements if all States were to cover present needs in full and not the exact amounts that Congress should make available from the Federal Treasury from year to year. How much can be used must be determined as the States gradually increase their appropriations for the work. Tables 1 and 2 show what the requirements may be for the next 5- and the next 20-year period.

Likewise, in those States which make State aid contingent on a definite showing of the expense by the landowners, the amount of public funds called for will be contingent on what the owners are prepared to match.

AID IN PROTECTION AGAINST INSECTS

The general situation as to insect attacks and a plan for meeting it are discussed in the section of this report entitled "Protection Against Forest Insects." Some phases of this job are on all fours with that of protection against fire. The work logically divides into four main classes; research, survey, local control, and control of attacks of epidemic character.

It is believed that public appropriations for survey and control work should be so worded as to make them available for assistance in the necessary research work.

The survey and local control can be done largely by the field organizations maintained for fire control, through extension of the time of seasonal employees, provided men especially trained in insect work are available for training and directing the fire control organizations in this work.

Control of insect attacks that have reached epidemic character call for emergency appropriations and special emergency forces. These can be best directed by Federal agencies, because of the infrequent occurrence of such attacks in any given State and the interstate aspects of such attacks.

It is believed that the survey phase of insect control should be financed by the public under the Federal aid system, with the Federal Government and the State sharing expenditures at a ratio of not to exceed 50 percent Federal. In actual control work on private land, the owner will usually contribute to or pay the entire cost of the work with supervision furnished by the State; and since insect attacks are to a large extent confined to trees of merchantable size it is not believed that private expenditures should be recognized as reimbursable by the Federal Government. No estimate of the private expenditures involved are, therefore, included in the direct Federal and State aid program. Estimates by experts in the Bureau of Entomology and Forest Service men familiar with field conditions indicate the need of approximately $500,000 annually for work of this kind on State and privately owned lands. The organization needed for the work now exists in part, and could be expanded to meet the situation within a 5-year period.

FEDERAL AID IN PLANTING

In the section of the report entitled "Reforestation of Barren and Unproductive Lands" the need is shown for a very greatly expanded program of Federal, State, and private planting if all of the forest lands of the country are to be made productive and are otherwise to measure up to their full possibilities in social and economic service.

It is not believed, however, that the Federal and State aid system is as fully applicable to the program of reforestation by planting as it is to protection and extension. As was brought out in the section of this report entitled "Factors Affecting Federal and State Aid," it has been found impracticable to furnish private owners planting stock free of charge. To do so results in a large wastage of money, since many people ask for the trees who have no well-formed plans for planting them, and who, in fact, may fail to plant them.

It has been pointed out that planting stock raised in large quantities in State-owned nurseries can be furnished at low cost. It is believed that all practicable public stimulus should be given to planting on privately owned land and that as a general rule the public should contribute one half the cost of producing nursery stock, this expense being shared equally by the Federal Government and the States. It is not believed to be desirable for the public to assist the landowner in the expense of preparing the site or in the actual planting.

The planting program proposes a very large increase in planting on State-owned lands. There are not the same objections to large Federal financial participation in this that have been raised against it on privately owned lands, but it is believed that the Federal Government's financial participation should nevertheless be only nominal. Here as in the case of land acquisition it is a question of investment in publicly owned properties. It is not necessary or desirable that the Federal Government and the States go into partnership with title and control resting entirely in the one or the other. It seems more logical, and less confusing, for each agency to spend whatever money it has for planting on its own lands. Federal-aid to States is not therefore proposed either for the growing of nursery stock for planting on State-owned lands, or for its actual planting.

Recommendations have been made for broadening the scope of section 4 of the Clarke-McNary Act in order that it may apply to planting on other than farm woodlands. To carry out this and the largely increased farm woodland planting would require the establishment of many new nurseries, the expansion of present plants, and the enlargement of present technical and supervisory staffs. It is in this phase of the work that the Federal Government now participates, and a continuation of such participation in a greatly enlarged program would require some increase in the Federal and State appropriations. A maximum annual Federal appropriation of approximately $350,000 and an equal amount by the States are indicated to carry out the 20-year program.

FEDERAL AID IN EXTENSION

The section of this report entitled Forest Extension, an Appraisal and a Program constitutes a discussion of the need for technical advice and assistance in the management of forest lands, both on farms and elsewhere. It proposes an increase from the present public expenditures of approximately $160,000 per annum to a maximum of $800,000 per annum under the Federal aid system, one half of the funds to be supplied by the States and one half by the Federal Government. The report proposes further that $500,000 or five eighths of the total shall be used for advice and assistance in the management of farm woodlands and the remainder for lands in State and in other forms of private ownership. It is believed that the importance of this phase of forestry warrants the building up of an organization for it as fast as qualified men can be provided, and that this can be done within a 10-year period.

COSTS SUMMARIZED

Table 1 shows what is being accomplished now (1932) and what might be done during the ensuing 5-year period if the proposed program were put into effect immediately. It should be noted that comparisons based on expenditures for any one year or for a period of years are not an exact representation of protection effort. In most of the States expenditures are very substantially increased during bad years but, since conditions are never equally critical over the whole country in any one season, the maximum of available protection funds for the United States as a whole is never reached in any one year. Thus in 1932 had the conditions in all regions been relatively as critical as they were in the Middle Atlantic States, the total expenditures for that year would have been nearer to 60 percent of the adequacy figure, than to the 40 percent which they actually averaged.

Table 2 constitutes an estimate of possible accomplishments by 5-year periods for the ensuing 20 years.

In making up these tables, it has been the aim to suggest a plan that would provide for a reasonably complete system of protection and extension activities over all of the privately owned and the publicly owned lands (other than Federal) by the end of the 20-year period. The plan has also been to suggest a rate of progress fitted to the relative possibilities of financing the program in the different States so as to proceed as rapidly as possible toward the accomplishment of the whole national program. This applies particularly in fire protection where present systems vary from 15 percent to 100 percent of the needs in the different regions.

Obviously those States whose protection systems are already nearly adequate can make the additional effort needed before many of the others can have under way even a fair percentage of what is needed. It is probably a safe prediction that, without the interposition of more extensive forms of Federal aid, those regions in which consummation of the protection program is indicated within 5 years will more nearly accomplish that result than will the other regions complete their programs in 20 years.

It should be emphasized that anticipated difficulty in financing the fire-protection program is the only reason for indicating a gradual progress in any region for more than a 5-year period. All of the States have made the necessary legal provision for Federal aid in fire control. All of them either have existing protection organizations that could be sufficiently expanded within that time, or could create the organizations needed.

The organization needed for insect control and extension activities could be provided within a 10-year period if necessary funds were available, although many States do not at the present time have any basic legislation providing for such activities.

It is for such reasons that emphasis has been placed on the desirability of the Federal Government increasing its participation in such ways as will lend greatest aid to the States most backward in their protection programs. What is urgently needed is an extension of the protection system to State-wide or near State-wide proportions. After that is done and the benefits from protection receive State-wide recognition, it should be much easier for the States themselves to intensify protection to the point of adequacy.

The planting program probably could likewise be pushed faster than is proposed if funds were available. It involves, however, some land classification, public acquisition, and a development of a planting technique that is more difficult, and consequently more time consuming, than is the case in protection from fire. The aim here has been to indicate a rate of progress that would bring the activity up to the average needed within a 20-year period.

TABLE 1.—*5-year program of Federal and State aid showing estimated expenditures for the fiscal years 1935–39 compared with 1932 expenditures*

[Amounts other than "Adequacy percent" in thousands of dollars]

Year	Agency	Fire protection									Forest planting	Farm forestry extension	Industrial forestry extension	Insect control
		New England	Middle Atlantic	Lake States	Central States	South	Pacific coast	North Rocky Mountain	South Rocky Mountain	Total				
1932	Federal	132	173	279	90	408	386	99	4	1,571	94	67		
	State	355	864	1,246	108	313	298	86	4	3,274		93		
	Private	14	2	24	19	179	574	274	9	1,095				
	Total	501	1,039	1,549	217	900	1,258	459	17	5,940		160		
	Adequacy percent	63	100	70	16	15	47	58	56	40		32		
1935	Federal	198	240	555	170	642	670	198	7.5	2,680.5	150	100	50	50
	State	400	715	1,640	150	471	322	93	5.7	3,796.7	150	100	50	50
	Private	15		25	20	286	637	276	10	1,269	300			
	Total	613	955	2,220	340	1,399	1,629	567	23.2	7,746.2	600	200	100	100
1936	Federal	198	240	555	190	900	670	198	7.5	2,958.5	162.5	125	75	100
	State	450	715	1,640	180	630	380	100	7.4	4,102.4	162.5	125	75	100
	Private	16		25	20	382	700	278	10	1,431	325			
	Total	664	955	2,220	390	1,912	1,750	576	24.9	8,491.9	650	250	150	200
1937	Federal	198	240	555	230	1,200	670	198	7.5	3,298.5	175	150	100	150
	State	500	715	1,640	210	787	420	107	9.0	4,388	175	150	100	150
	Private	17		25	20	496	763	280	10	1,611	350			
	Total	715	955	2,220	460	2,483	1,853	585	26.5	9,297.5	700	300	200	300
1938	Federal	198	240	555	260	1,500	670	198	7.5	3,628.5	187.5	175	125	200
	State	550	715	1,640	240	945	480	114	10.6	4,694.6	187.5	175	125	200
	Private	18		25	20	612	826	282	10	1,793	375			
	Total	766	955	2,220	520	3,057	1,976	594	28.1	10,116.1	750	350	250	400
1939	Federal	198	240	555	300	1,500	670	198	7.5	3,668.5	200	200	150	250
	State	575	715	1,640	270	1,100	540	121	13	4,974	200	200	150	250
	Private	19		25	30	650	889	284	10	1,907	400			
	Total	792	955	2,220	600	3,250	2,099	603	30.5	10,549.5	800	400	300	500
	Adequacy percent (at end of period)	100	100	100	45	54	78	76	100	70	60	80	100	100

TABLE 2.—*20-year program of State and Federal aid: Average annual expenditures by 5-year periods*

[Amounts other than "Adequacy percent" in thousands of dollars]

Year	Agency	Fire protection									Forest planting	Farm forestry extension	Industrial forestry extension	Insect control
		New England	Middle Atlantic	Lake	Central	South	Pacific coast	North Rocky Mountain	South Rocky Mountain	Total				
1932	Federal	132	173	279	90	408	386	99	4	1, 571	94	67	--------	--------
	State	355	864	1, 246	108	313	298	86	4	3, 274	--------	93	--------	--------
	Private	14	2	24	19	179	574	274	9	1, 095	--------	--------	--------	--------
	Total	501	1, 039	1, 549	217	900	1, 258	459	17	5, 940	?	160	--------	--------
	Adequacy, percent	63	100	70	16	15	47	58	56	40	?	32	--------	--------
1935 to 1939	Federal	198	240	555	230	1, 148	670	198	7. 5	3, 246. 5	175	150	100	150
	State	495	715	1, 640	210	787	428	107	9. 1	4, 391. 1	175	150	100	150
	Private	17	--------	25	22	485	763	280	10	1, 602	350	--------	--------	--------
	Total	710	955	2, 220	462	2, 420	1, 861	585	26. 6	9, 239. 6	700	300	200	300
	Adequacy, percent	90	100	100	35	40	69	74	87	62	--------	75	75	60
1940 to 1944	Federal	198	240	555	335	1, 500	670	198	7. 5	3, 703. 5	237. 5	245	150	250
	State	574	715	1, 640	415	1, 550	690	165	13	5, 762	237. 5	245	150	250
	Private	20	--------	25	50	762	906	292	10	2, 065	475	--------	--------	--------
	Total	792	955	2, 220	800	3, 812	2, 266	655	30. 5	11, 530. 5	950	490	300	500
	Adequacy, percent	100	100	100	60	64	83	83	100	78	--------	100	100	100
1945 to 1949	Federal	198	240	555	335	1, 500	670	198	7. 5	3, 703. 5	300	250	150	250
	State	574	715	1, 640	600	2, 000	840	212	13	6, 594	300	250	150	250
	Private	20	--------	25	65	875	1, 000	300	10	2, 295	600	--------	--------	--------
	Total	792	955	2, 220	1, 000	4, 375	2, 510	710	30. 5	12, 592. 5	1, 200	500	300	500
	Adequacy, percent	100	100	100	75	73	93	89	100	85	--------	100	100	100
1950 to 1954	Federal	198	240	555	335	1, 500	670	198	7. 5	3, 703. 5	335. 5	250	150	250
	State	574	715	1, 640	800	2, 500	1, 014	262	13	7, 518	335. 5	250	150	250
	Private	20	--------	25	65	1, 000	1, 000	310	10	2, 430	671	--------	--------	--------
	Total	792	955	2, 220	1, 200	5, 000	2, 684	770	30. 5	13, 651. 5	1, 342	500	300	500
	Adequacy, percent	100	100	100	90	83	100	97	100	92	--------	100	100	100

A POSSIBLE PROGRAM OF PUBLIC REGULATION

By W. N. Sparhawk, Senior Forest Economist

CONTENTS

	Page
Division of responsibility	1343
Scope of State regulation	1345
Scope of Federal regulation	1347
Public obligations accompanying public regulation	1349
Cost of program	1351
Conclusion	1352

As has been shown in preceding sections of this report, it is a matter of deep public concern that our forests be maintained in such a condition that they can continue to furnish timber, protect watersheds, check erosion, and contribute in other ways to the welfare of society. It has also been shown that there is a considerable degree of apparent conflict between the interests of society as a whole and what individual forest owners conceive to be their own interests, so that in pursuing his own objectives an owner may frequently do great harm to other individuals or to the public. Any public policy of forest conservation, whether it is built around public ownership, public assistance to private owners, or regulation of private owners, is based primarily upon the public's responsibility for protecting the public values of forests. The imposition of restrictions upon the handling of privately owned forests has further basis in the universally recognized duty of government to protect its citizens and their property against injury by others.

It is probable that the public interests can be served most effectively and economically, and with a minimum of interference in private enterprise, if the public owns a substantial portion of the forests. On the basis of present trends, great expansion of public ownership appears to be both desirable and inevitable. However, it is to be expected that considerable time will elapse before the public acquires all of the forest that should eventually be owned. Moreover, a considerable area is likely to remain in private ownership indefinitely. It may be desirable, therefore, to provide for a moderate degree of public regulation in order to protect the public interests and to redeem government's responsibility for protecting lives and property. A program of public regulation which might accomplish these purposes is outlined in the following pages. It is presented here as a suggestion for the form which public regulation might be expected to take, rather than as a program for immedate adoption in all particulars. Even such a moderate program is likely to be adopted only gradually, although several States have already made a considerable start.

DIVISION OF RESPONSIBILITY

The minimum degree of regulation under which the public can redeem its responsibilities is that which will prevent abuses which directly injure other individuals or the public. Under our form of government, the responsibility for preventing such abuse is shared by the Federal Government and the States. Under certain conditions the Federal Government clearly has jurisdiction; under other conditions, although the national interest is also involved in a general way, the responsibility is primarily the States'.

THE STATES' RESPONSIBILITY

Individual States have ample authority under the police power, and it is their proper function, to prohibit practices on privately owned forests which will harm the public or other individuals besides the owner. In addition to such regulation as may be undertaken in cooperation with the Federal Government for interstate or international reasons, each State should exercise such control as may be necessary:

(1) To prevent injury to persons or property within the State, or to property of the State or subdivisions thereof (including land or other property which the public intends to acquire).

(2) To promote the public health, including prevention of stream pollution, stabilization and protection of municipal water supplies, preservation of recreation values, etc.

(3) To protect roads, railroads, waterways, and streams used for irrigation and power purposes.

(4) To protect game and wild life in general.

(5) To promote the general welfare within the State by preventing depletion and waste of resources and the consequent ruin of business, industries, and communities, within the limitations established by the constitutions of the State or the United States. States individually or jointly through compacts can probably act to prevent the waste of forest resources, as California, Oklahoma, and Texas have attempted to do in the case of gas and oil.

FEDERAL RESPONSIBILITY

The Federal Government's interest in and responsibility for conserving forests have been recognized repeatedly by the Congress. The act of 1897 provided for reserving and administering the national forests "for the purpose of maintaining favorable conditions of water flow and to furnish a continuous supply of timber for the use and necessities of citizens of the United States." The Weeks Law of 1911 provided for acquiring and managing forests, and also for cooperating in the protection of private forests, to protect the watersheds of navigable streams. The Clarke-McNary Act of 1924 provided for contribution from the Federal Treasury to assist in the protection of forests in general, and for promoting forestry on private lands, because the maintenance of forests was recognized as essential to the national welfare.

Beyond question, the authority of the Federal Government is paramount in the protection of forests or other property belonging to the Government (including forests which the Government intends to acquire), in the prevention of damage of an interstate or international character, in maintaining the navigability of streams and harbors, and in the promotion of the national defense. Within these limits jurisdiction of the States and the rights of individual property owners are clearly subordinate. There can be no reasonable doubt but that the Federal Government has the responsibility and the legal right to exercise such control over both public and private forests as may be necessary to accomplish these objectives. If the Federal Government has the power to spend Federal funds in purchasing forest land for these purposes and in restoring a forest cover on such lands, it is logical to conclude that it also has the power to prevent the destruction which will make such acquisition and reforestation necessary.

SCOPE OF STATE REGULATION

FORESTS IN GENERAL

It does not seem to be practicable for either the States or the Federal Government at this time to require that private forests be managed on a sustained-yield basis or under the supervision of foresters. It is desirable, however, that each State should follow the example already set by several States and adopt the following minimum requirements with respect to all private forests except those so small in area or so isolated that their destruction can harm no one but the owner. It may also be desirable for States, groups of States, or the Federal Government to cooperate with the forest industries in regulating output so as to prevent waste of the resource and insure its perpetuation through sustained yield.

PROTECTION AGAINST FIRE

(1) The creation of abnormal hazards should be prohibited. These include large accumulations of slash; extensive clear cutting where topography, soil, and climatic conditions favor excessive drying out or rapid spread of fire; and careless use of fire, such as brush burning or operation of railroad and logging engines without taking due precautions against the start and spread of fires.

(2) To the extent that fire hazard arises from the activities or negligence of owners or operators, they should be required to bear a large share of the cost of prevention and suppression, either directly or through support of organized associations, or preferably through contribution to the State (special fire-protection assessment). They should be also required to construct and maintain suitable firebreaks around slashings or other areas where there is special danger of fires starting or spreading. Protection of forest property against fire hazards which do not result from action or negligence of the owners should as a rule, be a responsibility of the public. An owner of a forest, or any other sort of property, who pays taxes, is entitled to protection against damage by outside agencies, at public expense.

PROTECTION AGAINST INSECTS AND DISEASE

In the case of serious insect or disease infestations which threaten to spread to the forests of others, the State forester or other official should be authorized to prescribe preventive or control measures, where effective measures are known, and to require the interested owners to cooperate in their execution, up to a specified maximum cost per acre.

NOTICE OF CUTTING

Owners or operators should be required to notify the State enforcement authority in advance of any commercial cutting (i.e., except a thinning or improvement cutting) of more than 5 acres. Advance notice might be dispensed with where the operation follows a previously approved plan, but in that case the appropriate authority should be notified on completion of the cutting, in order that the area may be inspected to see that requirements for slash disposal, etc., have been complied with.

REGULATION OF CUTTING

Timber cutting far in excess of market requirements is contrary to the interests of the individual timber owners as well as of society as a whole. It tends to depress prices of forest products so low that the owner gets nothing for his stumpage, and in many instances the operator does not even recover the costs of logging, manufacture, and distribution. Industrial chaos results. Much of the timber that is cut is wasted, and the growing stock which is essential for continued timber production is unnecessarily depleted. Owners then have neither the incentive nor the financial resources to keep their land productive, and much of it, after being so badly wrecked that it can produce nothing of value for many decades, sooner or later reverts to public ownership. Consumers reap very little benefit from the lower prices while they last.

It is obvious that orderly production, adjusted to the growth capacity of the forests as well as to the demand for forest products, would in the long run be best for the timber owners and producers as well as the consumers and the public as a whole. General public control over production is not advocated at this time. However, it may be practicable for States or groups of States, or, preferably, for the Federal Government to cooperate with the industry in working out methods for stabilizing timber production and marketing which will safeguard the interests of producers and consumers and the general public. Cooperation of this character would be especially desirable for the purpose of preventing waste of resources and demoralization of industry in the Pacific northwest and in the South. Such an arrangement should involve a sufficient degree of public control over the allocation and rate of cutting and the management of the forest to insure permanence of the industries in given economic units and also might include public assistance to both operating and nonoperating timber owners.

PROTECTION FORESTS

Each State should provide for the classification of forests where the maintenance of a continuous forest cover is essential in order to prevent damage to persons or to public or private property.

The State should require that these forests be handled in such a manner as not to jeopardize their protective value or endanger the property or welfare of others. In general, this would mean merely prohibition of deforestation, guarantee that cut-over areas will be reforested by natural or artificial means, and maintenance of a forest cover. Sustained yield management would not be required, but should be encouraged.

The decision as to classification should preferably be handled by a State board, composed of qualified experts. It should be initiated either by the board itself, or upon application of an interested State department or of municipalities, associations, or individuals.

The general requirements should also be formulated by the State board. Both in the classification of protection forests and in the formulation of restrictions on their management, the board should be required to consult the forest owners as well as representatives of the local communities or other parties whose interests may be involved. The State forestry department should be charged with the specific application and enforcement of the law, subject to appeal to the board.

Some, but by no means all of these protection forests will also be classified as Federal protection forests, as provided below. In such cases there should be no conflict of authority. Both State and Federal governments should have concurrent jurisdiction to enforce their respective requirements. Generally, however, the State and Federal requirements will be similar. Where the State laws and enforcement organization are adequate, the enforcement of Federal requirements can be delegated to the State agency, subject to Federal inspection and with appropriate Federal contribution toward the costs.

SCOPE OF FEDERAL REGULATION

PROTECTION FORESTS

CLASSIFICATION

The first step in a program of Federal regulation would be to provide for classifying and listing the forests that should be subject to Federal control because of their relation to navigable waters, to national defense, or to national forests, national parks, or other national property, or in order to prevent damage to persons or property beyond the boundaries of a State. These might be termed "Federal protection forests." Appropriate legislation should prescribe the general principles upon which the classification is to be based and the general methods of procedure, and should set up a suitable agency with authority actually to carry out the classification. The classification itself is a quasi-legislative task. One method would be for Congress itself to designate protection zones by law, somewhat as additions to the national forests in certain western States have been handled since 1907. This method has certain merits, but probably would be unnecessarily cumbersome. A better way would be to authorize a suitable impartial commission or board to decide upon the classification.

The National Forest Reservation Commission, which passes upon proposed Federal purchases of forest land, might be reorganized as to functions so as to become the classifying agency, under the name of National (or Federal) Forestry Commission (or Board). This would be appropriate and logical because the protection zones will correspond in a general way to the areas within which the Government owns or is acquiring forest land, and because a considerable portion of the protection forest now in private ownership may eventually be acquired by the Government.

The Board should classify protection zones on its own initiative, or upon application by the Forest Service, the Bureau of Chemistry and Soils, the Reclamation Service, the War Department, Federal or State power authorities, a State, a city, an association of water users, or any other group or individuals whose interests would be affected by the treatment of forests in a State other than their own. So far as practicable classification should be carried out under a comprehensive and systematic plan, rather than in a hit-or-miss fashion on the basis of individual applications. Those areas should be classified first which the most obviously have protective value of more than local significance. The classification should be made only after an examination by experts, and after all interested parties have had an opportunity to be heard in support of or in opposition to the classification.

Logically, the Federal Government should have authority to prevent devastation of any forest within a classified Federal protection zone, regardless of its ownership. Ordinarily, a forest owned by a State, county, or municipality would be conservatively managed without Federal interference. In the comparatively few instances where this might not be done, it is probable that a sufficient degree of control would readily be relinquished to the Government in return for equitable assistance in fire protection, reforestation, and road building. This contingency could be taken care of by authorizing the Federal Board to enter into cooperative agreements with States, counties, or municipalities under which their forests within Federal protection zones would be handled in a manner approved by the Board and would then be entitled to the same Federal contributions as those granted for private forests.

RESTRICTIONS ON MANAGEMENT

Restrictions should be based on the general principles, which should be incorporated in the law, that the forest must be maintained in such a condition that it will continue to afford protection against erosion, floods, and drought, and that it may not be handled in such a manner as to jeopardize its own continued existence or to endanger neighboring protection forests, forests belonging to the Federal Government, or forests in other States. The same principles would apply in the case of forests along the Canadian border, where mismanagement might cause injury to forests or other property in Canada.

Methods of handling which tend to increase risk of fire, windfall, insects, etc., should not be allowed. Deforestation of more than a very small area (perhaps 5 or 10 acres) of these protection forests should be allowed only by special permission of the enforcement agency (with right of appeal to the Board). Such permission should be granted only after examination on the ground, public hearing, and agreement by the owner to reforest the land within a definite period if it ceases to be utilized for other purposes. In case the land is particularly susceptible to erosion, permission to clear should be contingent upon the owner's agreement to adopt preventive measures, such as contour plowing or terracing.

Detailed regulations and restrictions should not be prescribed in the law. These should be worked out for each locality by the enforcement agency, in consultation with State or local advisory boards composed of forest owners, State forest officers, representatives of municipalities, and other interested parties. The Federal Board should decide in case of disagreement between the local boards and the enforcement agency. The regulation should cover such matters as fire protection, slash disposal, methods of insuring natural or artificial restocking, methods of cutting (percentage of stand to cut, conditions under which clear cutting is permissible, etc.), and restrictions on grazing. Provision should be made for the reforestation of land which is already denuded, including abandoned crop and pasture land, where a forest cover is needed for protective purposes.

Within the limitations prescribed, an owner would be free to cut when, where, and as he pleased, and no permit would be necessary. Sustained yield management would not be required.

To facilitate inspection of the cutting, the authorities should be notified each year in cases where an area larger than 5 acres is to be cut over. In order to protect the operator, at least in the larger operations, he should be allowed to submit a plan of work covering method of cutting, slash disposal, provisions for fire protection, etc. Upon approval of this plan, with such modification as might be agreed upon, and as long as he operates in accordance with it, he should be considered as complying with the law and should be free from further restrictions. The Board should reserve the right, however, in case of any material change in conditions, or in case the operation should be evidently resulting in destruction of the protective value of the forest, to require changes in methods, after due notice and hearing. Cutting operations should be inspected regularly, and the inspectors should have power to stop operations where the requirements are not being complied with.

ENFORCEMENT AGENCY

The application and enforcement of public control over Federal protection forests, other than those owned by the Federal Government, might be carried out by agents of the Federal Board. In Sweden the foresters attached to the county boards (local boards also) are responsible for seeing that the regulations are complied with. They are entirely independent of the State forest service, which confines its activities to management of the public forests. In this country, however, it would probably be better to have the Forest Service act as the enforcement agency. The Service already has a certain degree of responsibility for the promotion of private forestry and maintains a staff of inspectors in connection with cooperative fire protection and distribution of planting stock under the Clarke-McNary law. Moreover, the protection forest zones will embrace not only a large proportion of the existing national forests but also large areas now in private ownership which probably will sooner or later be added to the national-forest system. It does not seem to be either necessary or desirable, therefore, to create a separate agency whose functions would to some extent parallel or overlap those already performed by the Forest Service.

PUBLIC OBLIGATIONS ACCOMPANYING PUBLIC REGULATION

As has been pointed out, a forest owner is not legally or morally entitled to compensation for refraining from acts which would directly injure the persons or property of others. Elimination or avoidance of fire hazard resulting from his own operations should be entirely at his own expense. At the same time, however, he is entitled to expect that the public will help to protect his property against fire and other damage caused by others.

Protection forests, moreover, are in a sense quasi-public forests, even though the private owner retains the title. The owner may be required to sacrifice income or undergo expense purely for the benefit of other individuals or the public as a whole. The cost of carrying out such requirements, so far as they do not return a direct benefit to the owner, should be recognized as an obligation of the public. Public funds contributed for these purposes should not be regarded as a bonus or gratuity, or as a bribe or bait to induce the owner to adopt the desired practices. Adoption of these practices should be mandatory; but the public, which enjoys the benefits, should pay the costs.

THE STATES' SHARE

FIRE PROTECTION

Each State should provide fire protection for all forests within its borders, except those owned by the Federal Government. The cost should be paid partly from the State treasury (with such contribution by towns or counties as may be agreed upon), partly by Federal contribution (see below), and partly by a contribution from the owners, either in the form of a special fire-protection tax or in some other form. Except for the costs of eliminating hazards resulting from operations, all of which should be borne by the owners or operators, it would be reasonable to expect the public (Federal Government, States, and smaller units) to pay at least 50 percent of the protection cost for ordinary nonprotection forest and 75 to 100 percent in the case of protection forest. Where the owners are in no way responsible for the fire hazard, public agencies should pay the entire cost of protection. The States' share might be 25 to 75 percent for nonprotection forest, 25 to 50 percent for State protection forest, and 0 to 25 percent for Federal protection forest.

In order that owners may know fairly definitely what protection will cost them, in case they are required to contribute, it might be desirable to provide that the assessments shall not exceed a fixed sum per acre in any one year, and that the actual amount to be collected in each year shall be determined by the State forestry board, subject to this limitation. It might be desirable in some instances that the State also collect a small assessment from the owners of nonforest property which benefits directly from the maintenance of the forests (e.g., water users, recreation interests, etc.). This is done now by several California counties.

FOREST PLANTINGS

The State should furnish planting stock and technical advice and supervision at nominal cost for afforestation in classified protection areas, except where the land has been denuded in violation of the regulations. In cases where owners may be required for reasons of public interst to afforest land already denuded, the entire cost should be borne by the public.

FOREST TAXATION

The State should provide that the assessed valuation of protection forests (Federal or State) for purposes of taxation shall take into account any reduction in value due to restrictions on their management.

FEDERAL GOVERNMENT'S SHARE

Inasmuch as the necessity for preserving Federal protection forests is based on national needs, and since the benefits will accrue primarily to the inhabitants of other States rather than to the owners of the land or to the States within which the forests are situated, it is equitable that the Federal Government should bear a considerable share of the costs of maintaining these forests, even where it does not own them. It is proposed, therefore, that the Federal Government should pay a large portion of the protection costs in addition to providing the enforcement personnel (inspectors) and paying the costs of classification.

The Federal Government would be justified in paying 50 to 100 percent of the cost of fire protection for forests within the Federal protection zones—the proportion to depend upon the relative benefits from protection to the landowner, to the State or local community, and to the Nation as a whole, and upon the extent of hazard due to other causes than the owner's operation. The owner should bear the full cost of slash disposal and other measures designed to avoid the creation of hazard. The entire cost of protecting federally owned land should, of course, continue to be borne by the Federal Government.

Because of the relation of forests outside the Federal protection zones to the general welfare of the country, the Federal Government is justified in continuing the present policy of contributing toward the cost of protecting these. A reasonable ratio would be 50 percent for forests within classified State protection zones and not more than 25 percent for ordinary nonprotection forests.

The division of protection costs would then be as follows:

	Federal Government	State	Private owners
	Percent	*Percent*	*Percent*
Ordinary nonprotection forest	25	25–75	50–0
State protection forest	50	25–50	25–0
Federal protection forest	50–100	25–0	25–0

This arrangement would recognize the responsibility of the Federal Government for insuring the protection of forests of interstate significance, regardless of action by the States or the owners. At the same time, it would respect the principle of cooperation with the States in protecting forests in general, and hence would retain the stimulus to State action that is provided by the Clarke-McNary law.

The above Federal contributions should apply not only to private forests, but also to those owned by States, counties, or municipalities and located within the designated protection zones. In the case of such publicly owned forests, however, Federal assistance should be granted only if and so long as the forests are managed in a manner satisfactory to the Federal Board.

COST OF PROGRAM

The cost to the public of a program of regulation such as that outlined above can be estimated only very roughly, and with a very wide margin of error. It would depend on how large an area should be classified as protection forest, and on the division of costs between the public and the forest owners. The public would have to pay as much or more if the forests were brought into public ownership. A large portion of the costs would also be borne by the public under a policy of public assistance to private owners, even if no regulation were involved.

The major costs peculiar to a program of regulation would be the expenses of the Federal and State forestry boards or their agents in classifying protection forests and formulating regulations, and the costs of maintaining a force of inspectors to see that regulations are complied with. The work of the boards would be heavy during the first few years, until the bulk of the classification is completed; after that the task would be considerably smaller. Expenses of the Federal board might be about $50,000 a year, and of the State boards about $100,000 a year altogether. The preliminary task of classification, which perhaps would be spread over a 5-year period, might cost altogether $250,000 for Federal protection forests and $150,000 for State protection forests. Enforcement of the law might require 50 to 60 Federal inspectors, at a total cost, including salaries, travel, and clerical assistance, of about $500,000 a year. Additional cost to the State forest departments for enforcing fire laws and restrictions on State protection forests might aggregate $150,000 a year.

At a rough estimate, possibly 160 million acres of the present privately owned commercial forest area might fall within Federal protection zones, and 65 million acres additional within State protection zones. This would leave about 172 million acres of privately owned nonprotection forest. If the costs of protection should be divided somewhat as proposed above, and if the total cost of protecting privately owned forests should be about $20,000,000, as indicated in another section of this report ("Protection Against Fire"), the Federal Government would pay approximately $9,500,000 a year, the States about $6,750,000, and private owners about $3,750,000. This does not take into account the noncommercial forest area, a relatively small proportion of which is privately owned, nor the abandoned farm land that is reverting to forest but not yet classed as forest land.

CONCLUSION

The plan outlined above is in line with the policies which have been worked out by a large number of countries that are in approximately the same stage of economic development as the United States. It recognizes the fact that a large proportion of our forest land will continue for many years in private ownership. It seeks to avoid interference with private property beyond what is necessary to safeguard the rights and welfare of the public. Except for requirements designed to prevent the spread to other property of fire, insects, and disease, mandatory regulation would be limited to classified protection forests, and there only when such interference is necessary. The Federal Government would have jurisdiction over protection forests where the injury threatens to pass State boundaries or to affect Federal property or interests within the State. Beyond this, control would be left in the hands of the individual States. In either case, the control measures would be formulated largely by boards or commissions in consultation with forest owners.

The plan does not contemplate that the cost of maintaining the protective values of the forest would be imposed upon the private owners. It proposes to apportion the costs of the program in an equitable manner between the Federal Government, the States, and the forest owners, as nearly as possible commensurate with the benefits to be derived. It endeavors to retain the principle of cooperation in a form which would induce the willing acceptance of regulation by forest owners, and which at the same time would insure that the public expenditures in aid of private forestry will accomplish the results that are intended.

As stated at the beginning of this section, a program of public regulation such as has been described would supplement an acquisition program. It would aim at preventing the devastation of forests which the public might later acquire, and at protecting the public interests, to the extent that might be necessary, in forests which will remain more or less indefinitely in private ownership. Public regulation is not advocated as a general substitute for eventual public ownership of a large proportion of the Nation's forest land.

ENLARGING THE CONSUMPTION OF FOREST PRODUCTS

By CARLILE P. WINSLOW, Director Forest Products Laboratory

CONTENTS

Page
Introduction: the changing demand for forest products 1355
The importance of maintaining and increasing consumption 1356
Action proposed and recommended 1357
  Industrial organization and practice 1358
    Transportation 1358
    Selective logging and sustained yield 1360
    Integration of industries 1360
    Production from small timber holdings 1361
    Improvement of production 1362
    Merchandising 1364
  Research in forest products 1365
    Better use of wood in construction and fabrication 1367
    More marketable products and lower costs 1372
    Pulp and paper 1379
    Wood—its structure, composition and properties 1386
    Cooperation in forest products research 1391
Meeting the challenge of consumption trends 1393

THE CHANGING DEMAND FOR FOREST PRODUCTS

There is the same call for aggressive, farsighted action in maintaining the consumption of forest products that there is in providing for the growth and protection of timber stands.

Upon the unparalleled timber resources of the United States hitherto have been built industrial, financial, and commercial activities of enormous magnitude, which in capital invested, in value of products, and in labor employed, rank collectively in the foreground of our national developments. Such facts, considered alone, might be taken as a guarantee of the permanent place of forest commodities in our civilization. But present industrial trends outweigh the past in obtaining a realistic picture of forest industry and its economic importance to the country.

Wood in the past has for many purposes been practically the only available material for use, and this has been a controlling factor in pioneering and in the middle period of development in the United States. Under primitive conditions, wood is the only fuel. Hundreds of logs make the dwelling.

Even for crude machinery, wood serves as a ready makeshift. At a later stage, with railroads opening up new farming, forest, and mining territory, forest and sawmill products came into their own for the settlement of the countryside and the rapid erection of whole towns, with their full complement of stores, warehouses, and first industrial plants. The wooden house becomes in a measure standardized and is then often elaborated as an expression of wealth. Such developments are perfectly familiar to Americans. They mark a very recent period of our history. Continuing to some extent even now, they help to explain our relatively high per capita consumption of wood. But the projection of an unlimited and uncontested use of wood into the future is a matter of uncertainty that must be frankly faced.

The declining trend in lumber markets since 1906 is amply presented elsewhere in the chapter of this report entitled "Timber Resources and Requirements." We cannot overlook the facts that had the per capita lumber consumption from 1899 to 1909 continued, the 1929 gross consumption would have been almost twice what it was, and that in an era of prosperity and building activity perhaps never reached before (1920–29), when the consumption of all other major building materials was greatly increased, gross lumber consumption actually decreased or barely held its own.

A review of present facts and tendencies of the market situation leads to the inevitable conclusion that without positive and determined action to enlarge them, our requirements for forest products in the future may not be what they have been in the past, either in form or in quantity; that a high per capita consumption of forest products in the past is no guarantee of high consumption in the future; and that new forms and economies in the use of the basic raw materials, such as are represented by developments during recent years in steel-skeleton construction, veneered coverage, and large-size structural units of light weight, may upset the most exact predictions based on past experience. We must recognize that uses long held by wood are being contested both by old materials refined by science and by new materials of scientific origin, promoted with the aid of extensive technical knowledge of their properties. Metal lath and window sash, synthetic boards, all-metal automobile bodies and airplanes, steel desks, metal doors and trim, composition floors, concrete bridges and piling, asbestos and tile roofing, metal poles and posts, synthetic wood alcohol—these are but a few illustrations of the prevailing tendency toward substitution. The real and constant quest of modern Americans for technical progress and improved products and service are factors that must be candidly faced in planning for the future. If in the case of any material, wood included, it is assumed that it will stand for all time on the strength of its past and present state of perfection, there is almost a certainty, because of the increasing interchangeability of materials, that its use will diminish.. There is an essential distinction to be drawn here between the need for wood as a cheap raw material for conversion by industry into salable commodities in a highly competitive field, and wood or forests essential in themselves for other purposes.

THE IMPORTANCE OF MAINTAINING AND INCREASING CONSUMPTION

In future plans for forestry, persistent effort must be put forth to retain, to recapture, and to expand the market for forest products, which means the use of modern competitive methods that have come into play in the development of other materials; nor is the motive solely one of profits to particular forest-using industries.

Forest markets are an essential factor of land use. With action which will bring assurance of future markets large enough, diversified enough, and profitable enough, we can look forward to the permanent and profitable use of millions of acres of land for commodity forest purposes—land that seems to be suitable for no other purpose than timber growing, or for timber growing in connection with other services that a productive forest can render. Future supplies of merchantable timber need not be sacrificed in hasty efforts to liquidate the entire forest wealth of the country. Wood, a resource of basic importance in a wide variety of uses and one that is indefinitely renewable, can be kept available for the American public, thus insuring the advantage of possessing an abundant raw material upon which to draw both in normal times and in national emergencies.

Through assured markets for forest products, hundreds of thousands of workmen will be benefited both by a continuing wage and by the social values of employment in a settled location. Huge investments of capital in timber lands and industries can be kept productive. Local governments can be assured a steady basis of tax revenues, and States and communities can benefit from a continuing source of wealth. A vital problem of farm land can be solved. In farm woodlands there are over 126 million acres, an area nearly one fourth as great as the acreage of improved farm lands.

Beyond and in addition to the foregoing, there is one consideration that alone would justify public interest in the broadening and stabilization of forest markets. This is the investment that the Government has at stake in its 140,000,000 acres of national forests in the United States. With an ownership of more than 550 billion board-feet of timber, worth, at a conservative estimate, half a billion dollars on the stump, every 10 cents per thousand feet change in stumpage value means a $50,000,000 change in the value of these holdings. And stumpage values, of course, will go up or down as markets for forest products go up or down.

ACTION PROPOSED AND RECOMMENDED

In the effort to hold, recapture, and expand the market for forest products, definite accomplishment along four distinct lines is imperative: First, a lowering of costs to the consumer; second, an increase in satisfaction in the use of the products through improvement of properties and qualities; third, the development of new products or modified products; and fourth, the promotion of popular acceptance and use of the products by all legitimate contributory means that may be effective.

Fortunately, there are many favorable opportunities for such efforts. In the first place, markets for forest products have been proving unprofitable or unsatisfactory, at least in part, because of improper selection of material, improper preparation for use, and improper design of the commodity or structure, and not because the material lacked the intrinsic properties desired. In the second place, chiefly because of an abundance of raw material, the forest-using industries have in the past utilized only from one third to one half of the actual material grown or available on the stump. The remaining one half to two thirds, which costs as much to grow as the portion heretofore used, has been put to no economic use. This so-called waste material holds great possibilities for the production of commodities which can return an added profit to the production costs of stumpage. Further, for any given production, efficiency in utilization means reduction in forest cut. Such reduction of cut becomes at once translated into increased forest supply. This increase is of a form and character of immediate rather than potential value. It is cumulative without additional expense. A saving made today is repeated tomorrow and perpetually thereafter. A board foot saved by improved utilization becomes a board foot saved annually, thus augmenting our waning timber supply, while also lowering production costs.

In the light of these objectives, the retention and enlargement of forest consumption and markets is a problem of industrial efficiency in production and distribution, of scientific and technical advance in the improvement of forest products, and of general attitude and policy reflecting public interest and support for the economic success of forestry. The specific lines of action that are proposed here will be taken up in that order.

INDUSTRIAL ORGANIZATION AND PRACTICE

Low production costs and a high degree of satisfaction to the consumer call for important changes in organization and practices with respect to forest holdings. In the face of a rapidly shrinking supply of standing timber, the wood-producing and wood-using industries from New England to California are confronted chronically with flooding of markets and a profitless and demoralized price structure. The results are seen in wasteful cutting and conversion of timber stands, in sacrifices of quality strongly reactive upon the reputation of the product, in hurried liquidation of present properties, and in short-sighted disregard of regrowth. Examination as to the actual prevalence and seriousness of such conditions is important, but the facts are already sufficiently known and acutely enough felt to justify study of remedial measures. Lumber is the principal commodity from the forest and presents the most aggravated marketing problems. Consequently major attention at this point will be devoted to that product, although many of the requirements with respect to lumber apply with equal force to other forest products.

TRANSPORTATION

Forest products are at a distinct disadvantage in the struggle for lowered costs because of the heavy transportation factor. Lumber carries a railroad freight cost averaging $283 for every $1,000 value, compared with $263 for cement, $198 for common brick, $79 for iron and steel, and $58 for wall board. In the decade 1914–1924 the average length of haul from mill to place of use increased from 360 miles to 725 as the nearer sources of supply approached exhaustion.

Improvement in transportation costs lies along three lines: (1) Adjustments in freight rates, (2) elimination of unnecessary cross-hauling, and (3) putting into maximum production those forest areas closest to centers of use.

The principal action thus far to cope with transportation costs has been that taken by the forest industries in securing more favorable rates from the railroads and in utilizing the water route via the Panama Canal. Railroad rates are, of course, subject to further change. Existing freight rates for commodities in general are the resultant of slow adjustments over long periods of years as between competing industries, sections, and public carriers. Lumber tariffs have probably not reached the same degree of stability that exists in the case of other commodities, because of the shifting centers of lumber production. Active study may disclose that it is to the advantage of both railroads and industry as well as to the public served to bring about changes in the rate structure for lumber in particular. However, revisions large enough substantially to change the relation between competitive commodities seem unlikely. The possibility of reduced transportation costs by means of inland waterways, such as the Lakes-to-Gulf route, warrants careful scrutiny by timberland operators.

The elimination of the hidden but nevertheless heavy burden arising from crosshauling is a factor to be taken into account. The National Lumber Manufacturers' Association estimates that, of the annual freight bill for lumber of half a billion dollars, one tenth is for crosshauling that is unnecessary. Few deliberate steps have been taken actually to cope with the situation. It is axiomatic that to realize the advantages of home markets the standards of efficiency in production methods must be kept abreast of those in the regions most aggressive in reaching out for distant markets. The concentration of sales and promotion activities in those zones nearest to source of supply is a logical thing for the forest industries to work out, as systematically and energetically as possible. As each producing region studies its full possibilities, considerable reduction in crosshauling should follow.

Important as reductions in freight rates and crosshauling are, basic improvement can come only as the supply is brought closer to the centers of consumption. Much land in the East from which timber was cut in the earliest days is still forest land, but the growing stock on these forests close to centers of population has not been adequately maintained. Nevertheless, even the diminished output that has continued in this region has kept down the transportation factor to some extent.

The bulk of high-grade lumber must necessarily be supplied by the West until eastern and southern forests are thoroughly rehabilitated. Meanwhile the large uses for lumber, at present at least, are for sheathing, framing, concrete forms, boxes and crating—uses served by such material as is now being produced in substantial quantities from second-growth forests of the eastern and southern region and can be relatively easily supplied in the future. Certain measures that may confidently be anticipated to improve the competitive status of lumber, such as treatments against decay, insects, fire, and shrinkage, are as well met by second growth as by virgin growth. Also, for many of the industrial uses of lumber, the increasing trend toward cutting of the parts direct from the log at the point of production rather than from lumber at the factory removes many of the present objections to smaller second growth.

It is the production of the common grades of lumber from the East and South that keeps the price of western lumber down, and of the high grades from the West that keeps the price of eastern lumber down. This competition is at the expense of "skinning" the growing stock in the East and the leaving of tremendous waste in the woods in the West. Building up the older age classes in the forests in the eastern half of the country is essential in the interest of eventual lower costs. The owners of eastern timberlands have difficulty in comprehending this fact in the face of continued shipment of cheap western timber. The need for measures looking to the wider acceptance of the facts is obvious, but reliance on education as now conceived is not very promising.

Holding back the cutting of growing stock to safeguard future productivity means, it is true, a higher average transportation cost for the immediate present as a larger percentage of lumber comes from the West. The loss in competitive position of lumber products that might arise from this cause should be resisted by the development of improved and economical timber products such as mill-fabricated items, plywood for sheathing, concrete forms, siding, and the like.

From the single standpoint of minimum transportation costs it is obvious that the North Atlantic States, the Lake and Central States, and the South, by their greater accessibility to the chief centers of use, warrant first attention in intensified forest management.

SELECTIVE LOGGING AND SUSTAINED YIELD

Markets are being supplied with lumber from private holdings at higher production cost and of lower average grade than would be the case if selective logging were generally practiced. It has been convincingly established in every producing region that the smaller timber is handled at a loss in most lumber operations. In southern pine, for example, the small trees are often cut at a loss of approximately $10 per thousand board feet, which adds to the price at which the larger timber must be sold to yield a profit.

Three important steps toward lowered costs become possible as the principle of selective logging and sustained yield is put into effect: (1) Elimination of material that fails to pay its way; (2) saving the investment in plant, mill town, and forest land that in the case of migratory operation must be charged off in the price of the products at a rate as high as $2.50 per M for typical southern mills; (3) realization of lower raw-material costs by making possible the stable operation of integrated secondary industries. The last point is considered in more detail under the next heading.

From an economic point of view, timber owners can now hardly afford to neglect the practice of selective logging wherever the character of the timber permits. But often important obstacles to its practice or privately owned lands remain to be overcome. Further discussion of measures that are required to realize the benefits of selective logging and sustained yield occurs elsewhere in this report. The fact that needs to be borne in mind at this point is that substantial reductions in current production costs are made possible by selective logging.

INTEGRATION OF INDUSTRIES

Integration of the sawmill with pulping plants, veneer and dimension mills, and the like, is a major requirement for lowered costs. For the most part, forest industries have been specialized, and each has made its independent draft on the raw material supply. The resulting wastes are proverbial. However, enough has been accomplished thus far by industrial integration to point out possibilities of improvement. Within recent years the pulp industry on the West coast has come to operate to a large extent on the waste from logging and sawmilling operations, with the result that pulp mills 2,000 miles from Chicago can compete with those 200 miles away. In the Lake States, in a few instances, the full run of the forest is sorted under an integrated scheme of operation according to its suitability for the sawmill, dimension plant, veneer mill, and distillation plant; or, in other forest types, for the pulp mill, sawmill, box factory, and specialty plants.

In certain operations in the southern pine region, integration of sawmills, pulp mills, and veneer and plywood plants has been accomplished. Large holdings that are being developed primarily for pulpwood contain saw timber or medium-sized trees that will grow to saw timber size before the stands are cut for pulping. The plans call for cutting the high-quality logs into timber products to defray a large part of the cost of stumpage, instead of pulping all material indiscriminately. In Sweden the close integration of lumber and pulp industries results in close and flexible utilization in accord with market conditions, a diversification of product, and maximum value from the raw material. Basically such developments are sound and, other things being equal, are the way to minimum costs.

Integration is not necessarily confined to large plants and heavy capital investments. Partial integration already exists in the small-scale operations of sawmill, turning plant, and novelty factory in New England and of tie mill, flooring plant, and spoke and handle factory in the Middle West. For the most satisfactory functioning, however, we must look to adequately financed and fairly large units.

It has been through integration of sawmill and pulpmill operation that the greatest advances have been made thus far. It is between these units that great progress in the immediate future may be looked for in the virgin forests of the West and in the second-growth forests of the South, although there are limits as to the part that the lulp mill can play. There are good grounds for anticipating also a much wider integration, on a smaller investment basis, between plywood manufacture and lumber production in regions where virgin timber is still readily available and between pulpwood, naval stores, and timber products in the Southeast.

It is not to be assumed, of course, that all production from the forest will be on an integrated, diversified basis. Lumbering on a small scale lends itself to individual effort, particularly in regions where the timber supply is scattered, and account must be taken of the fact that small independent operations will always play a part in the ultization and marketing situation. Integration in this country has not progressed to the point where it is more than an indication of the part that it must play if large-scale markets for forest products are to be maintained. The way to the realization of its benefits must be kept open through continuing research and organizing and management effort.

PRODUCTION FROM SMALL TIMBER HOLDINGS

Portable sawmills share responsibility to a greater degree than large ones for putting out substandard products which undermine confidence in lumber. By stressing cheapness, small mills have played strongly into the hands of those elements in the building trade that have engaged in speculative building and shoddy construction. So unskillfully has the product been marketed that it has constantly disturbed the equilibrium of the entire price structure. A large proportion of the remaining saw timber, particularly in the eastern half of the country, is in farm woodlands for much of which the small sawmill is the strongest bidder in sight.

Fortunately, there is now a strong trend toward improved quality from the small mills, so far as accuracy of manufacture is concerned. It is becoming recognized that small mills properly designed and operated and cutting good timber can produce good lumber. In a growing number of instances capable business men directly or indirectly are managing the operation of groups of small mills. But it is the existence of large numbers of both good mills and poor mills that brings up for serious consideration the small mill as a factor in future marketing developments.

Small mills have always shown a marked sensitiveness to business conditions. Their credit is generally limited, and, while they increase rapidly and their added production tends to hold down prices on the ascending side of the business cycle, on the descending side they reach their credit limit quickly and drop out. On the assumption that flexibility of quantity and stability of price are desirable, limited credit may here seem to be beneficial. On the other hand, in strengthening the competitive drive in the lumber market, limited credit appears as a detriment by forcing a glut of products on the market. Measures for strengthening the credit of small sawmills have been discussed by the industry. It is important to realize, however, that measures that do not also work to the benefit of the owner of the standing timber will merely foster the increase in output of the least efficient mills.

The key position in adjusting small-mill production to requirements of orderly manufacture and marketing is held by concentration plants buying rough lumber from these local units. In the case of softwoods, practically all the lumber produced by portable mills is finally seasoned, surfaced, graded, and put on the general market by concentration plants. In hardwoods, which are commonly sold rough, the output is but infrequently graded or marketed through comparable central units. The nucleus around which improvements can be put into effect are thus present in the one case but lacking in the other. The small-dimension-stock plant appears as the most logical unit to take the place among portable hardwood mills that the concentration plant now holds with softwoods. Fundamentally, control must be hinged upon demonstrating to the concentration units the advantages to them of improved operating practices.

A measure of the effectiveness of counsel, demonstration, and education will be available from what the Southern Pine Association is now attempting among small-mill operations in its territory. The program of this organization is more systematic and extensive than any other thus far undertaken. The aim is to aid the small mills in their weakest spots with higher standards of manufacture, seasoning, grading, and, particularly, marketing. Success in this industrial program will indicate that similar measures can be depended on for small mills in other producing regions; failure would suggest that control must be worked out by more drastic measures.

If the small mill continues to hold its present position, the best markets for lumber cannot be protected in the future unless marked improvements are put into effect.

IMPROVEMENT OF PRODUCTION

Much dissatisfaction with lumber is due to shortcomings that are under the control of the manufacturer and that technical research has already shown how to correct. There are three lines of improvement entirely beyond the experimental stage that are clearly capable of putting production on a sounder basis: (1) Moisture content control through better seasoning; (2) improved selection and grading; (3) making decay-resistant lumber generally available.

The shrinking of lumber after being built into a finished product provides one of the most prolific sources of dissatisfaction with the performance of wood. In one part of the country the point has been reached where a group of building and loan associations refuse to finance homes constructed of a species that is customarily shipped green and undersize into that region. The remedy—to use only seasoned wood—is clear but too frequently ignored by producers who, more than the other groups involved, have a controlling hand in the matter.

The moisture content at which lumber for different building purposes is stabilized with reference to shrinkage is known. Commercial shipments of building lumber as a rule deviate widely from the plain requirements. Practical methods to measure the moisture content and drying equipment to produce uniform seasoning are readily available on the market. The necessary improvements need only to be put into effect. For its own protection, the lumber industry should see to it that seasoned lumber is made more practical to obtain and that the use of unseasoned lumber is limited to places where its subsequent seasoning and shrinkage will not be harmful.

The present principles of grading, so far as the bulk of the lumber output is concerned, are essentially those of years ago, when competition between building materials was less keen than at present. Despite the degree of progress registered in the adoption of American Lumber Standards, the prospective buyer of lumber is now faced with a bewildering array of species, specifications, and conflicting claims. Furthermore, the lumber grades bearing the same name in different species often differ widely in quality. Confused and skeptical, the prospect often turns to other materials easier to specify and offering more satisfactory guarantees of quality. Architects, with whom rests to a large degree the choice between wood and other materials, have strongly criticized the present lumber grading system. While leaders in the lumber industry recognize this dangerous situation and are taking steps to remedy it, market requirements call for prompter action. The Timber Conservation Board has recommended something in the nature of a "pure food law" for lumber that would require shipments of lumber and timber in interstate commerce to be graded and indentified in accordance with publicly recognized standards of grading and inspection. The desirability of careful selection of species and grades for the more exacting uses can hardly be overemphasized.

Resistance to decay and insects is a property in great demand for material that must be used in damp places, in contact with the ground, or wherever moisture tends to accumulate in the wood. While resistance can be provided to some extent from the heartwood of naturally durable species, it must frequently be provided artificially by impregnation with suitable preservatives. Properly preserved timber, with few exceptions, is not easily obtained by the rank and file of lumber users. Attempts are being made in several parts of the country to make suitably treated timber available through retail lumber yards.

They will no doubt succeed in the course of time, but they need to be expanded and strengthened. Much care is required to assure that only well-treated material is provided.

MERCHANDISING

Lumber, the principal forest product, has thus far largely "sold itself." Several factors, unnecessary to enumerate, have contributed in the past to a strong position for lumber and obviated the necessity of strongly organized merchandising effort. But conditions of the past no longer prevail. Lumber is contesting with other materials for practically all its markets, and there is now imperative need for promotional effort in the broad sense. Until up-to-date merchandising has had a chance to show its full effects, previsions of permanently inadequate markets lack realism from the economic point of view.

In the long run, merchandising effort must be based, first, on sound foundations of quality and technical control, as discussed in preceding paragraphs, and, second, upon coordinated sales policies that insure to the consumer material of the type and quality to meet his particular requirements.

The groundwork has already been laid in American Lumber Standards for fundamental improvement that is well within the hands of the trade to put into effect, either by itself or with the aid of public agencies in certain respects. Standard grading and grade marking are measures that are particularly needed as a guaranty of quality in which the consumer can put his confidence. It is even more essential that the lumber industry itself take cognizance of the species and the grades and qualities within a species that are inherently suitable and justify promotion for a given use.

Organized demonstrational and educational effort must be applied to focus attention of the buying public upon the merits of wood properly prepared and selected, and how to avoid dissatisfaction in its use. Mistakes of design and construction to be avoided—as, for example, the use of untreated wood in damp locations, or lack of measures for fire-resistance—must be made plain to the users.

Many prejudices against lumber will disappear as the producers take a firmer grasp of quality control and preparation of the product. Others will be removed only by educational work. For the technical buyer, especially, data regarding the properties of wood and its use in engineering structures must be made available in manuals and textbooks comparable to those available to him in the use of other materials.

The merchandising that will be effective in holding and extending markets for lumber products involves not only attention to the major established outlets but also recognition of new deeds and latent wants, and provision of ways to meet them through the use of lumber. For example, good roads and the automobile (still too largely unhoused) open to the masses opportunities for recreation, which in turn offer new possibilities for lumber if satisfactory cottages and camps can be made available on a low-cost basis. Only active merchandising can develop such possibilities. The widespread desire of home owners for wood paneling and finish presents another challenge and opportunity that only effective merchandising can meet. City dwellers are still inadequately housed, and farms are getting but a fraction of the buildings and repairs that they need.

Only when lumber and other wood products are presented to the consuming public in the best possible condition, with adequate demonstration of their merits, with a catering to unsatisfied desires, and in accord with the findings of research, will it be time to consider whether the national market for such products is indeed "inadequate".

RESEARCH IN FOREST PRODUCTS

It is submitted here that scientific research in wood and wood products, steadily prosecuted and the results applied, can be followed up to large practical gains in the production and marketing of the forest yield—in the lowering of costs, in insuring greater satisfaction to the consumer in the service of the product, and in opening the way to new products and enlarged uses.

Other products have felt its influence; in fact, scientific research is the foundation and pattern of the industrial age. Through research, products have been refined and diversified, new materials developed, mass production in old and new lines made possible with consequent cost reductions, and mass consumption awakened beyond the conception of past generations. Most of our modern industries—steel, aluminum, and other nonferrous metals, alloys, glass, ceramics, refractories, petroleum, foodstuffs, machinery, textiles, plastics, cement, chemicals, electricity, etc.—have come to depend on the research of the scientists and the technician for their continued progress and the expansion of their markets.

With iron and steel, for instance, it was primarily the lowering of production costs through the development of the Bessemer process, followed later by the development of the open-hearth process, which enabled structural steel to be marketed at prices which have resulted in the use of millions of tons. It was the microscopic and phase-rule studies of the coarser and finer crystal structure of steel that enabled research to correlate crystal structure with strength properties, and that have guided the development of steels of such innumerable different properties as manganese steel, which is hard and tough and used in grinding machinery; tungsten steel, which is self-hardening; vanadium steel, which withstands shocks better than other steel; chrome steel, indispensable in cutting tools; nickel steel, which resists corrosion; duriron, which resists the attack of acids; and stainless steel, containing chromium, which retains a mirrorlike surface indefinitely. Without these successful efforts to lighten, strengthen, and cheapen the material, our sleek and satisfactory automobiles of today would still be the lumbering tractorlike vehicles of the early nineties, and our rapid-fashioning machinery would be impossible.

Aluminum, industrially speaking, is a comparatively "new" metal. For years it was known that it was the most extensively distributed of the metals, making up about 7 percent of the earth's crust. It only awaited a means for obtaining it cheaply in metallic form from the clays and rocks in which it occurs. One hundred years ago it sold for $160 a pound. Research had brought down this cost by successive stages to $4 a pound in 1886, at which time the present electrolytic process was discovered. This discovery finally placed aluminum production on a remunerative commercial basis and was responsible for an output of more than half a billion pounds of the metal in 1928. Today, through continued intensive research, the cost has been further reduced and the quality and strength have been improved to such an extent that aluminum and its alloys are already competing with steel in important structural uses, while wider markets are being opened up in paints, coatings, welding, sheet uses, and machinery.

Research in glass composition and manufacture has brought about three revolutionary developments in the last 20 years—the production of Pyrex glass, improved optical glass, and shatter-proof glass—all to the great advantage of American industry. The present rayon industry, with production values at $150,000,000 in 1929, is a direct outgrowth of research carried out with the purpose of duplicating the product of the silkworm. The development of cellulose lacquers has opened up an entirely new chapter in automobile and furniture finishes. To cellophane, another new research product in the cellulose group, has been awarded the credit for a considerable share of the financial success of one large corporation during the depression. Research in the preservation and refrigeration of foods has practically "reversed the seasons" and has been the foundation of enormous industrial developments of late years. Long and patient research in the fixation of nitrogen has at last made it possible to extract from the air the most essential fertilizing element for our soils.

Over against the large body of American industries that have enjoyed significant progress and profit through research, the majority of wood industries seem to occupy a place apart. Scientific standards have rarely been the controlling factor in logging, for instance, or in the production and use of lumber. The use of wood is guided less by modern technology and more by traditional business practice and artisans' rules. It is a fair assumption that, in the strenuous competition of industries for present-day markets, neglect of fundamental and applied research on a given material will impose a severe handicap on its use. Only in certain fields of chemical utilization—such as pulp and paper, rayon, and plywood—has wood maintained or improved its position as a basic material, and it is in these particular fields that research has been most actively supported and applied.

Along with the development of scientific and technological research, there must be increasing attention to all of the economic factors involved. Without such information, authentic in source and comprehensive in scope, neither the selection of specific research projects nor the effective application of the results can be guided most soundly. As an example, in the field of pulp and paper research the proper choice of species for first study and the adoption by industry of the results, if successful, both depend on knowledge of the cost and future supply of these and competitive species, as well as knowledge of production costs, transportation costs, and their relation to and effects upon competing production. Problems of this nature are so important and complex that they must be recognized and adequate research organized for their solution. To be most effective, such research should be closely coordinated with the scientific and technological phases of the work.

BETTER USE OF WOOD IN CONSTRUCTION AND FABRICATION

Research must show the way to radical improvements in wood construction. The convenience, low cost, and other advantages of wood must be combined with simplified, efficient, and cheap design and erection, and better preparation and maintenance of the material, to produce more durable and economical structures. Wood has lost ground competitively because of insufficient technical progress in its use. Since more than 60 percent of the lumber produced in the United States is used in the construction of buildings, it is especially important that this market be retained and expanded. Intensive research vigorously prosecuted offers the only practical way to keep wood abreast of the continuous technical progress being made by its competitors and thus to avoid unnecessary substitution of competitive materials for wood.

UNIT CONSTRUCTION

Wooden houses cost too much. Present designs and methods of building coupled with the normal tendency toward higher wages and shorter hours have reacted to discourage building. The obvious answer is mass production of wood units that can be assembled quickly and inexpensively, in line with similar developments that are occurring in steel and concrete housing. The progress that has been made thus far is entirely inadequate.

Research therefore has an urgent practical objective in seeking to develop practical forms of wooden-unit construction for dwellings and larger buildings. Full-scale tests of special forms of wall, floor, and roof units should be made. One type of material that offers itself for use in large units is plywood. Ready-made plywood wall sections embodying self-contained insulation may prove an economical and satisfactory replacement for the present composite wall of wood and plaster. The development of such untis involves several phases of research—practical and efficient design; tests for strength and weather resistance; the production of a cheap, permanent, water-resistant glue; and of sightly, weather-tight joints. Another possibility is the development of built-up lumber units of an interlocking type. In any kind of unit construction, the design of the structure as a whole requires adequate architectural study to insure acceptable variety, appearance, and convenience.

ENGINEERING RESEARCH

Great improvements in building construction can be made without waiting for the development of mass production. Built-up wooden columns and glued laminated arches and beams should replace much expensive solid timber. They permit better selection of the wood for quality, favor refinement in design, conserve the large sizes of timber, and make possible the utilization of smaller, cheaper units of lumber. Laminated wooden arches are especially suitable in the construction of halls, hangars, and other buildings of large open span and are finding extended use in Europe. They need thorough testing and adaptation to American use. The Forest Products Laboratory has investigated the problem of the built-up column and determined a form of construction that is cheaper and approximates the strength of solid timber. At present, effort is directed toward the production of a glued laminated beam that will require high-grade lumber only at the top and bottom, where stresses are highest, and can utilize low grade and short-length material to fill in. Accomplishment of this objective will make available beams of better and more uniform quality and will lead to closer design, lower costs, and increased markets for low grades of lumber.

Conventional joints and fastenings in heavy timber construction are inefficient. Modern engineering efficiency and high costs of material will no longer permit lavish use of material to obtain strength and rigidity. Methods must be improved so that joints of greater durability and reliability can be made at less cost and with more efficient utilization of the strength of the wood. Marked progress has recently been made in determining strength values for nailed and bolted joints and correcting previous handbook figures that varied as much as 600 percent. Further work for research lies in determining the holding power of screws in different woods and in developing metal jointings in the nature of dowels or keys to supplement bolt bearings in structural members. Experience abroad indicates that wood adequately jointed may successfully contest the market in large and increasingly important uses, such as radio masts, transmission-line towers, and higheay bridges.

The basic design factors of wood structural members are not sufficiently known. Timber structural design at present is a process of approximation. In the average wooden structure there are parts vastly oversized for the strength required and others inadequate to resist racking, bending, compression, and other live-load effects. Since we must consider three axial directions in wood there are 3 Young's moduli, 3 shear moduli, and 6 Poisson's ratios, or 12 elastic constants to be taken into account. To compute rightly the elastic behavior of wooden members under stresses requires experimental determinations and the development of engineering formulas far in advance of those now available.

An example of the practical benefits to be gained today by a revaluation of design factors in wood members is the more satisfactory and economical design of bridge beams in shear advocated by the Forest Products Laboratory and recently adopted by engineering professional bodies. Acceptance of the new rule means that railway and highway bridge stringers can be sized to meet actual shearing stresses rather than the stress figures formerly used, which often exaggerated the actual condition by 50 to 100 percent. Wooden bridge design has been made more exact and the sizes of beams have been brought more closely within the range of commercial production, so that there is less reason to turn to more expensive material.

Greater attention must be paid to designing wooden structures for appearance. The very great economy of treated wood for highway bridges and similar purposes is frequently ignored because other structural materials are believed to produce more pleasing or imposing structures. Introducing art into wood-bridge design will serve the double purpose of expanding the markets for wood and getting larger returns on public expenditures.

FIRE RETARDANTS

The development of a complete, inexpensive fire-resistant treatment would do much to regain immense markets for wood that are now closed. Building code and underwriters' requirements limit the use of wood for exterior walls in residential, industrial, and commercial buildings in urban areas. To a less extent wood framing is handicapped in competition with less combustible materials. Fire-resistant treatments are now available but too expensive for general use. Recent studies encourage hope for marked improvement. Several highly effective chemicals are known, and combinations of certain chemicals give promise of even better results in respect to economy, noncorrosive effect, permanance, and other advantages. A combined treatment embodying fire resistance, decay and insect resistance, and reduction of shrinking and swelling properties is a major objective that may ultimately be attained.

PREVENTION OF SHRINKAGE

A successful treatment to prevent shrinking and swelling would do more than any other single accomplishment to simplify and cheapen the use of wood in doors, sash, trim, furniture, floors, and a host of other wood products. It would also result in so much better service and satisfaction that the popularity of wood for these purposes would increase, and expanding markets would inevitably result. Chemicals have already been found that reduce the shringage as much as 90 percent, but the wood so treated shows a decided tendency to become wet and drip in a very damp atmosphere. The problem is to find new chemicals of high effectiveness that are free from this and other disqualifying objections or to find ways to change the injected material to nonhygroscopic forms. Increasing knowledge promises that the desired result is by no means impossible.

PREVENTION OF DECAY

Decay is a major menace to the permanence of wooden structures. Unprotected wood in service is being lost through premature decay at a rate comparable in magnitude only with the destruction caused by forest fires. Research and experience have shown that decay prevention is possible by the proper use of preservatives and often by improvements in design and construction to avoid the conditions that favor decay. Railroads and other public utilities annually treat millions of cubic feet of ties, poles, piling, construction timber and miscellaneous lumber with creosote, zinc chloride, and other preservatives. The serviceable life of the wood is increased two to ten times, and enormous financial savings result. Wood is thus enabled to retain large markets which would be closed to it if only the relatively short life of untreated wood under decay-producing conditions were attainable. The sphere of research in the continued development of wood preservatives and treating processes is very large, necessitating the collaboration of the engineer, the physicist, the chemist, the entomologist, the plant pathologist, and the toxicologist.

The desirability of lower treating costs is obvious. The danger of reducing the strength or causing unsightly defects during treatment is very real. The total recognized loss in value from this source amounts to a large sum annually. The unrecognized losses undoubtedly are still greater. Refinements in treating technic resulting from research and the development of milder but effective treating schedules can eventually reduce these losses to an insignificant amount. These same improvements can also decrease the very appreciable losses that result from inadequate or ineffective treatments and can lengthen the average life obtainable from treated timber.

Adequately treated timber is not readily available to the average small consumer. The undesirably high cost of thoroughly treated timber and the lack of adequate distribution machinery have limited its use principally to consumers who can purchase in large quantities. Greatly expanded markets await the developments that will overcome this obstacle.

A special need for research is in the development of effective but inexpensive decay-resistant and insect-proofing treatments of lumber for dwellings and general building construction. The preservatives must be substantially odorless and colorless, satisfactorily paintable, cheap, permanent, simple in application, and harmless to man. The definite progress that has been made in this direction must be greatly extended. Public demand is already insistent.

Proper design and construction can eliminate much of the decay and insect attack in dwellings that is now costing home owners large sums of money. Investigations have already shown that contact of wood with the ground must be avoided, adequate ventilation provided around all wood near the ground, and all practical precautions taken to keep the wood dry. While the application of present methods of control will aid materially, a survey of existing conditions followed by an evaluation of the factors affecting decay and insect damage is badly needed to indicate the most efficient methods of eliminating building losses that are all too prevalent at present.

PAINTING AND MOISTUREPROOFING

The painting of houses and other woodwork constitutes an expensive item of maintenance that must be reduced. It is often the factor that determines the choice of other building materials in preference to wood. The Forest Products Laboratory has shown why the painting problem is more serious with some woods than with others. The general remedy, however, is not yet at hand, because our most abundant construction woods are the ones hardest to keep painted. It seems necessary to find paint vehicles more permanent than any now known. In the whole storehouse of nature and modern science some combination of pigment and vehicle must be possible that will cling to wood like part of its own substance and furnish the artisan with a material he has never dared hope for. If such a combination is possible it remains for chemical research to find it.

There is a constant demand for moistureproof coatings for wood. No simple coating process has yet been found that is more than about 75 percent effective in preventing moisture changes, and this degree of effectiveness gradually decreases upon continued use or exposure. Highly effective and durable coatings would find extensive use and would greatly improve the performance of wood in such products as boats, airplanes, furniture, and a wide variety of factory products.

GLUING

The development of a cheap glue that will be as strong, as reliable, and as permanent as the wood itself will enormously expand the opportunities in the economical and profitable use of wood. The glues thus far developed by research from blood, animal tissue, casein, vegetable proteins, and phenolic resins are excellent in many ways and a great improvement over those available in the past. As yet, however, they all fall short of the ideal in several respects. Today the woodworker takes great pains to dry his lumber carefully and to bring it to the proper moisture content for gluing with minimum trouble. Then, with most of the glues available, much of this tedious work is undone by putting back into the wood a large amount of water along with the glue. Not only must time be taken to dry the wood again, but many perplexing difficulties of woodworking arise from the sweeling and shrinking of fine surfaces and carefully made glue joints owing to glue moisture changes. Glues that contain no water are being developed. The active aid of research is needed to make them cheaper, better, and more generally adaptable to all kinds of gluing.

DESIGN OF FABRICATED PRODUCTS

The most efficient design of shipping containers is handicapped because of lack of specific knowledge of the hazards of transportation. The work of the Forest Products Laboratory in the design of wooden boxes and crates has been largely instrumental in bringing American containers and packing methods from recognized inferiority to recognized superiority and in reducing freight damage claims by millions of dollars annually. But this is not sufficient. Further study and surveys are necessary to determine the nature and causes of damage to containers and their contents in both domestic and export shipment and to translate the needs of shippers into terms of wood.properties. The importance of this work is measured by the present consumption of wood in shipping containers, which takes one sixth of our lumber cut and a large and increasing proportion of our pulp production.

In the same way as for boxes and crates, the available data on wood properties should be applied to the fundamental design problems of other fabricated wood products. To almost every manufacturing industry using wood, a more perfect knowledge of the material and its properties and better means of turning its properties to account in service would conduce to improved wood products and markets. In the auto-body industry, for example, keener selection and evaluation of wood for posts, sills, and rails would avoid defects of weakness and brashness now sometimes encountered, would perhaps extend the range of usable species, and would retain the elastic riding qualities of wood coachwork, while suitable preservative treatment would eliminate the decay hazard, and better gluing and jointing would guarantee strength and long service life. Wood is and has been used in thousands of manufactures, from barrel staves to Pullman interiors, but its supremacy for these uses is by no means permanent or assured. To maintain or increase the market for wood obviously calls for more competent technical knowledge of the material and better use of that knowledge by the designer.

MORE MARKETABLE PRODUCTS AND LOWER COSTS

Like all other materials, primary wood products are susceptible to improvement through research in form, properties, and costs. Assets capable of withstanding strong competition lie latent in the present forms in which wood is marketed—high strength per unit of weight, integrally bonded structure, impregnating qualities, nonconductivity, working and finishing qualities and chemical derivatives, all in supplies that are continuously renewable. But other materials in recent years have established standards of service which necessitate changes in wood products.

Improvement, in order to yield maximum benefit, must be based first of all on better compliance with the requirements of the consuming market. Refinement of product with lowered cost is unquestionably the outstanding consumer demand and the largest factor controlling the future markets for wood. Refinement beyond an elementary stage involves also diversification of product to deal with the inherent variability in the wood itself and in the trees and forests from which it is cut, and diversity in any adequate degree involves the integration of producing units. The main lines through which improvement is to be worked out, discussed under a previous heading, call for factual information, some of which is already at hand, but much of which still is to be obtained. Further research in this field consists chiefly in working out the means of applying in practice the results from more fundamental scientific knowledge.

THE FORM OF PRODUCT

Research has advanced the use of materials competing with wood through the development of sheet or fabricated units of large size, high strength, and light weight. The advantages from the standpoint of both structural and architectural design and installation costs have given rise to a consumer demand that is permanent and irresistible. Forest products have given partial recognition to such demand, but the possibilities have only been touched and are limited only by the amount of research that is devoted to them. The possibilities and actual developments in pulp and cellulose products in this field are well recognized. In the field of plastic and molded products there has come to partial realization a method whereby the cellulose and lignin of wood are combined with aldehydes to form a product which can be molded under pressure to give a hard material very resistant to moisture change and with no tendency to shrink or swell.

Since the lignin, cellulose, and aldehyde can all be obtained from the wood, the process may be considered as self-contained, and only the small amount of mineral acid needed to effect the reaction need be supplied from other materials. If the results thus far obtained are substantiated by further work, large-scale production of new products from what is now waste material is made possible. Additional possibilities lie in the discovery of a satisfactory binder for consolidating fine particles of wood and also in the glutinizing of the surfaces of wood particles to produce adhesion when pressure is applied.

Plywood as a major wood product commands attention on account of the possibilities it holds in units of large size, high strength, and lightweight ratios, in low cost treatments to guard against fire, decay, and shrinkage, and in full utilization of the log. Plywood already is changing from a product for decorative purposes to one that has wide possiblities in the structural and fabrication fields. Great significance lies in the fact that its consumption, like that of of pulp, paper, and cellulose, is rapidly increasing, whereas that of other forest products has been on the decline. The development of a good water-resistant glue and of commercially practicable methods of using it have put plywood into entirely new uses, as in concrete forms and wall and floor construction, in which lumber has been losing markets to other materials.

The present conception is that only large-size clear logs can be used economically for the manufacture of plywood. Research is needed to determine whether relatively poor and small logs may not also be usable through the development of improved cutting methods and machines. Methods may be found for cutting veneer from logs now suitable only for lumber so as to make the saving in kerf compensate for the loss in speed of cutting.

Even failing the development of radically improved cutting methods, further attention to veneer production is almost certain to bring to light the practicability of using in structural plywood timber of lower quality than is now used.

Dimension stock has been proved by factory studies and actual practice to meet the requirements of many of the wood-using industries better than lumber. These facts have led to the shifting of machining operations from the factory in the distant city to the sawmill near the supply of timber. This has been particularly the case in the auto-body industry and to a less extent in the production of furniture and sash and doors. The saving in freight on waste and the better advantage in the cutting of the material from the log have proved to be important factors in reduction of costs to the user. It has been found from production studies in the Lake States that the use of improved operating methods and specially designed machines result in a higher material and monetary return from second-quality timber for mill-cut dimension stock than cutting the same quality or even a better quality of material into lumber. The further development of methods for producing high-quality dimension stock, including sawing, seasoning, and bundling, is required. Modifications need to be worked out not only to meet the requirements of consumers but to apply to different classes of timber and size and character of holdings. The need is particularly urgent to meet conditions in New England, because dimension stock production affords the key to the management of hardwood timberlands in that region and to the supplying of an important market with home-grown material of good quality. Especially important also is the development of dimension-producing units to serve as concentration plants for the output of hardwoods from farm woodlots in the North, South, and East.

SELECTION AND GRADING

In addition to the new and improved forms of wood that should be developed to meet modern demands, lumber itself through various improvements near at hand or in prospect can become almost a different product and thereby strengthen its own position both in cost and in quality.

In the case of a highly variable material such as wood, it is quite obvious that selection is the key to refinement, but in the case of lumber the basis of selection has never been adequately developed. Use requirements are met at present largely on the basis of the species and rather arbitrary grades determined by the occurrence of knots and the like. But a species possessiong high average shock-resisting properties, for example, has been proved by tests to yield substantial proportions of material no higher in shock resistance than species of much lower rating. The same applies to all the other properties of wood. For any assurance of getting qualities required, the consumer has had to rely heavily on the reputation of the supplier and of the locality of growth. In the noncompetitive era for lumber such practice may have sufficed, but it can hardly be expected to serve for the future. Research has established that the specific gravity test, which can be readily applied, is a good working index of many strength properties and a sound basis for classifying material of any species into high, low, and intermediate groups. New values will be realized as wood of low density is sent to those that want low density and wood of high density to those that want high density, rather than a mixture of all kinds to all users.

Experiments are under way to develop a strictly portable instrument for getting an instantaneous measure of the hardness of wood as an index of specific gravity. Such an instrument in the hands of a commercial grader will pave the way for radical improvements in selection to meet use requirements. Within the last 2 years an instantaneous tester for moisture content has been developed from fundamental work on the physics of wood. This instrument, now being sold by several makers, has led to marked improvements in providing consumers with properly seasoned lumber. Its further adaptation, together with a fuller development of moisture-content specifications, holds promise of removing many complaints against lumber.

Other reliable commercial tests are needed to measure and select for decay resistance, freedom from swelling and shrinking tendencies, toughness, resistance to abrasion, and many more properties in which wood exhibits a great variation. Aside from selective tests, science needs to provide ways of evaluating all the properties of wood so as to suit it more exactly to the purposes intended. The facts recently established as to the characteristic defects of the important softwood species need to be taken into account in the fuller development of use grades.

SEASONING

Poor seasoning has been the cause of much dissatisfaction with lumber and has resulted in heavy loss of markets. Great advance in recent years has been made as a result of research, but many problems still remain to be solved before seasoning is put on a basis that permits lumber to compete to its best advantage. Both artificial seasoning in dry kilns and natural seasoning in the open air are involved.

The need for kiln-drying arises from two main requirements. One is economic—to reduce freight costs, to reduce the quantities of lumber held and hence the investment, to reduce seasoning losses, and to fill orders on short notice. The other is physical—the necessity of having lumber drier than can be obtained by air seasoning in regions where the products are used in heated houses. For such regions and purposes lumber must of necessity be kiln-dried even if it is first air-dried.

Comparatively large and unnecessary losses are still incurred in current kiln-drying processes. Investigations to determine the causes and remedies for such losses have been under way for a number of years. A reasonably satisfactory empirical understanding of the manner in which seasoning defects are brought about and of ways in which they can be avoided or remedied has been obtained. The general effect of variations in the controllable conditions is sufficiently understood to make it possible to draw up reasonably satisfactory drying schedules. For the more common lumber products such schedules have been developed in the Forest Service for about 50 important American species, and additional schedules are being worked out.

An important cause of present poor drying practice lies in inadequate kilns and equipment. Research on drying schedules has carried with it the development of several new types of kilns and the perfection of control apparatus which have become standard equipment in the industry. As the drying of special forms, shapes, and sizes becomes more common, corresponding progress in drying equipment will have to follow.

A number of important seasoning problems still remain unsolved. Most of the work hitherto has had to do with lumber and other comparatively thin material. But ties and timbers of most species suffer excessive degrade during seasoning, with a corresponding loss in value. Many special sizes and shapes of dimension stock of various species still require study before satisfactory drying methods can be had. Certain groups of species cannot be satisfactorily seasoned by any known methods. Among these are southern swamp oaks and some of the other southern hardwoods. It becomes necessary, therefore, to develop some new and radically different method of seasoning which will permit this material to be seasoned in a reasonably satisfactory manner. Experiments now under way give some promise. It is quite within the realm of the possible that new methods may become applicable to all classes of wood products and may revolutionize the entire art of seasoning, with tremendous benefit to producer and consumer alike.

A large percentage of lumber and other timber products will for many years to come be air seasoned despite any conceivable developments in the kiln-drying processes. Commercial air seasoning is exceedingly variable, has a large rule-of-thumb element, and has been too largely without investigative basis. While it is obviously impossible to vary the conditions to which the stock is exposed, it is possible to control the extent to which these climatic conditions affect the stock by varying such factors as the size and shape of the lumber pile.

The development of antiseptic chemical dips to minimize stain and decay, particularly during air seasoning, is a matter of immediate practical importance. The extent to which air seasoning loss can be reduced by such means and by proper yard practice varies considerably with the type of mill. Large mills can feasibly reduce damage to a negligible point if they so desire; small mills, on the other hand, frequently are faced with the lack of any practically available method of preventing deterioration and consequently must suffer much larger unit losses than the larger operations. Since the smaller mills cut a large proportion of lumber that is subject to blue stain and are becoming production factors of increasing importance, especially in the Gulf States, the problem of devising efficient control methods for their use is one of real importance. Recent tests of antiseptic solutions give promise of yielding effective treatments that will be applicable to the use of small as well as large mills. Further work of this type is essential to insure the maximum satisfaction to the user of wood and the best returns to the producer.

The shipment, handling, and storage of lumber is another wide channel of loss for lumber values. Stock that has had the most careful manufacture and seasoning may suffer unaccounted increase in moisture content and attack by stain and even decay in its transit to the consumer via train, ship, and storage yard. The service of research can assist industry here by surveying the conditions of shipment and storage and recommending the proper safeguards against deterioration, similar in general to the measures which are effective in air seasoning.

CONVERSION

So many chemical and mechanical processes are involved in the conversion of logs into marketable products that they cannot be profitably discussed together. No consideration of products and markets is possible, however, without special recognition of the part these processes play. Conversion has received the greatest attention from within the forest industries themselves. It has undergone immense improvements, but it still stands to benefit greatly from continuing research. In the case of pulp, plastics, plywood, and dimension stock, conversion problems are touched upon elsewhere. Reference is made at this point only to lumber.

The larger sawmills operating on high-quality virgin timber have kept abreast of the most modern developments in machinery and methods. The losses in slabs, edgings, trimmings, and kerf are still substantial, but they have been reduced to the point where further reductions are extremely difficult. The pressing problems lie in the development of efficient units for the conversion of timber of a low quality and the smaller, scattered stands of virgin timber and second growth. Experiments indicate the practicability, under certain conditions, of an improved gang-saw mill and of a portable band mill to replace the present small circular mill. It has been shown that production costs can be reduced and the recoverable yield substantially increased through the use of these recently developed units. The possibilities in the portable band mill, in particular, need to be developed to the fullest extent and as rapidly as possible.

In all mills, improved technique for smooth dressing and surfacing is needed. Factors affecting the smoothness of surface, highly important to many uses, have been found to lie in the moisture content of the wood at the time of dressing and in differences in density and growth-ring structure. But only hints are now available as to the real solution of smooth surfacing free from tendencies toward raised grain and "fuzziness." Paint has been found to adhere better upon exposure to the weather if the lumber has been so cut that the bark side is machined as the face for painting. As practical ways can be worked out for taking into account the peculiarities of wood as they come to light, the aggregate effect in satisfaction to the user will be distinctly beneficial.

LOG GRADING

Preparatory processes and conversion largely determine the degree of consumer satisfaction, but the log supply is of primary importance in production costs. To put different classes of logs into the product to which they are best suited and to exclude unprofitable logs are basic to low production costs. The logs coming from any forest vary greatly in size and freedom from defect. Judgment alone has been the basis of the sorting process to date, but it has not been sufficiently accurate to prevent large losses to manufacturers attempting to use unsuitable material. Rules of thumb can hardly be expected to show whether veneer, lumber, dimension, piling, or pulp is the product into which a given quality of log should go to net the largest return. The little amount of systematic study that has been given to this subject has shown that attractive prices for veneer logs, for example, have encouraged millmen to sell their best logs for that purpose, not realizing that the extra yield of high-grade lumber from those same logs would often net more than is obtained for them as veneer logs. As the production of diversified products becomes more common, it is particularly important to have a basis for sorting the raw material according to the product.

The need for the development and commercial adoption of log grades is becoming more urgent as time passes not only for lumber but for pulp and dimension, veneer, and other products cut from logs. The increasingly important part played by logs cut by farmers for sale to lumber, pulp, and other mills emphasizes the need for log grades. In the case of pulpwood, grading on the basis of weight rather than volume is a fertile field for improvement.

Rough log grades have been in use for some time, notably in the Douglas fir region, where logs are bought and sold on the open market. Preliminary investigative work has been done to improve these grades, as well as to develop log grades for southern hardwoods, but no really systematic program has as yet been undertaken in any case.

Closely allied to the grading of logs is their protection against deterioration from discoloring and decay fungi. Under poor conditions of storage and handling that frequently exist, injury occurs which may continue undetected into the finished product. While the immediate conversion of logs into lumber offers the surest way of avoiding deterioration, storage of logs in the woods or at the mill is common practice. Storage of logs in water or rapid seasoning by piling on high skids has been used with varying degrees of success in attempting to avoid fungus attack. The need for developing more effective methods of control was apparent, in the Gulf States region particularly, from a recent survey in which more than 50 percent of the mills visited had from 5 to 50 percent of their logs infected at the time of sawing. Recent tests of antiseptic sprays and end coating materials offer promise of yielding treatments that will combine fungicide with insect-repellant properties and will be commercially practical.

SELECTIVE LOGGING FOR SUSTAINED YIELD

Broadly speaking, all lumbering operations are carrying on without definite information as to which qualities and sizes of logs are yielding a profit and which are entailing a loss in conversion. Small trees that are being felled and logged at a loss would comprise the nucleus for a new crop if left to grow. A new complexion is given to present values when only logs and trees which pay their way are harvested. Intensive studies of Lake States hardwoods, southern pine, and western softwoods bring out clearly that operators are logging and milling timber which carries hidden losses as high as $10 per thousand board-feet. When current costs and returns are considered along with the facts coming from silvicultural studies as to rate of growth and proper methods of cutting, the way is open to markedly sounder economic practices than now prevail, and means are provided for decreasing the current overproduction of low-grade material and in giving so-called cut-over lands new values readily recognized by timber owners and bond and banking institutions.

The industry can make distinct improvements by operating on the basis of facts already brought to light. However, questions are involved that cannot be answered from present information. The investigations that have been made have dealt almost entirely with lumber as the product and with operating equipment designed primarily for large timber. Basic operating guides to the forest industries need to be worked out in the way of time-output values for each timber product as produced from different sizes and qualities of logs and trees. They need to be in such terms that varying wage scales, overhead charges, and market prices can be applied to them to give exact figures applicable to the individual operator.

LOGGING EQUIPMENT AND METHODS

Realization of the full economies in selective logging calls for certain changes in logging equipment. Despite the great advances in logging methods that have been made in recent years, particularly in the West, research has shown that the ultimate has not been reached. Large reductions in cost become possible when more flexible methods are used in connection with selective logging. From the detailed information already obtained it is found that tractor logging can be used to a larger degree than at present to reduce heavy expenditures for closely spaced railroad spur lines and for heavy skidders. Only a start has been made in the accumulation of detailed knowledge along these lines, but it is sufficient to show what may be expected as full information becomes available. Power saws also for woods operations have already made their appearance as a means of reducing costs, but their real merit over present methods remains undetermined.

The heavy loss in breakage in felling large timber in the West has been found susceptible of considerable control. Accurate examinations have shown that the breakage in the merchantable volume of Douglas fir and western hemlock varies from 3 to 16 percent according to the felling methods and the topography. Appreciable reductions in breakage can be realized, as the influencing factors of slope, bedding, direction of felling, methods of payment, and supervision are singled out and individually dealt with.

HARVESTING OF NAVAL STORES

The harvesting of the resin crop from the pine forests of the Southeast stands to gain greatly through the modernization of methods that science can contribute. Naval stores products have held their own in commerce and industry up to this point in spite of the unnecessary waste and the crude practices applied to their production. But it is now widely recognized that if they are to continue longer as profitable industrial commodities, radical changes must be made throughout the processes of production and handling.

The scientific study that has already been applied has shown the practicability of maintaining the flow of oleoresin by light, narrow chipping at as high a yield as by heavy chipping. The establishment of this fact makes possible longer working and greater returns per tree. Two to three successive workings for periods of 5 to 8 years each now result in less damage to subsequent wood products than resulted from the shorter workings commonly carried on in young stands. To a considerable degree these improved methods have already been adopted in commercial practice. That further modification might be made by changes in the frequency of chipping also give promise of future important developments. The size of the tree has been found to influence greatly the yield of gum, and the dividing line between profitable ane unprofitable sizes for working has been fairly well established. The vitality of tree growth is known to have influence in the yield of resin, but vigorous-appearing trees which might be expected to give high yields sometimes prove to be low producers, and small trees to be large producers. Thus, there are factors at work affecting the yields that have escaped detection. It is highly important to the intensive management that must henceforth determine the profits of naval-stores operation to avoid cumbering the ground with low yielding trees, which reduce the profits from the normal and high yielders. The question of the proper number of trees per acre is being given intensive study, since the spacing of the stand influences crown size and other basic factors responsible for the best yields of both oleoresins and wood.

Timber products as well as naval stores must be relied upon as the crop from forests of the Southeast, and the proper integration of all products becomes a matter of primary concern. Piling, poles, pulpwood, staves, and excelsior have been produced from the timber operated for resin. Continued outlet is threatened, particularly in the case of staves, whereas in pulp the outlet promises to increase. The margin, however, is so slight, even with substantial gains in pulpwood, that no outlet can be lost without serious consequences. The system of management which takes into account the varied products so as to make each contribute to the maximum net return from the forest has yet to be established. The facts required as a basis of such management are complicated and difficult to obtain, but the importance of getting them as rapidly as possible is obvious.

PULP AND PAPER

The production of pulp and paper deservedly ranks as one of the most important uses of forest material, and its importance seems destined to increase. As shown in the section "Timber Requirements", the total national consumption of paper and boards increased steadily to 13½ million tons in 1929, and predictions made by various authorities place the annual requirements for 1950 anywhere from 24 to 30 million tons. Such a consumption would require an annual cut of pulpwood amounting, roughly, to 15 percent of our present annual cut of timber for all purposes. As a profitable use of large land acreages, the growing of pulpwood on a sustained-yield basis thus offers great promise for the near future.

It is not only as a quantity use of wood that pulp and paper manufacture takes an important rating. The quality and refinement of the product gives the industry a high labor and conversion factor, and the relative stability of its operations contributes to permanent community values. A recent study has shown that in the conversion of 1 million cubic feet of timber into lumber, planing mill products and boxes, 75 men were employed, $75,000 in wages was paid, and the resulting products were valued at $250,000; whereas, in the conversion of the same amount of wood into pulp and finally into a good grade of paper, the employees numbered 150, the wages were $200,000, and the finished products were valued at $900,000. The increasing dependence of the United States on foreign sources for its pulp and paper production is of considerable significance in this connection. As pointed out under "Timber Requirements", the quantity of foreign wood used in producing the paper consumed in the United States has increased steadily, until in 1930 the proportion had risen to 56 percent. In terms of wood use, the 1930 paper and wood pulp consumption of the United States was equivalent to approximately 13 million cords of pulpwood. Of this quantity, the equivalent of nearly 7,300,000 cords was imported. In terms of land use this means that perhaps 12 million acres of forest land in the United States were deprived of not less than a $50,000,000 contribution to the national market. In terms of labor employed, our 1930 imports of pulp and paper could be considered as equivalent to the "exportation" of full-time jobs for 70,000 American citizens.

Two main reasons may be assigned for this situation. The first is the present dependence of the paper industry upon a very few species. The second, which is related to the first, is the tenacious and long-standing concentration of the pulp and paper industry (the sulphate pulping group chiefly excepted) within easy transportation distance of the eastern spruce and hemlock forests and the large pulp and paper consuming markets. As the native supplies of northern and eastern spruce and hemlock have been progressively depleted, the natural tendency of large established industries has been to rely more and more on imports of these species from abroad (chiefly from Canada) or to move their mills over the border, rather than to migrate to distant regions of the United States and utilize new stands of similar or of different woods.

In view of the foregoing, the task of research in furthering the interests of our domestic pulp and paper production is clear. This is to increase the possibilities of economical production, higher yields, and better pulp quality from our native woods, both those now preferred for pulping and those not now used extensively or not used at all. Its accomplishment must be based on a varied research attack, for which the following lines are suggested:

1. Improvement of present pulping processes or the development of new processes to increase the usefulness of present pulpwood species.

2. The application of pulping processes to new species.
3. Increase in efficiency and knowledge of the fiber processing operations—beating, bleaching, refining.
4. Investigations of the variables of paper manufacture and of the mechanical factors underlying sheet formation and the production of finished papers.
5. Effective utilization of woods and mill waste.

The wood-pulping industry as it exists today has largely been developed by research, and the difficulties that the domestic producer has lately experienced in meeting foreign competition can be removed, not by less research but by more research, better integrated and consistently followed up in production.

IMPROVEMENT OF PULPING PROCESSES

The so-called standard pulping processes include three of chemical nature known commercially as the soda, sulphate, and sulphite methods. The first two are alkaline and the third is acid in character. The fourth process is strictly mechanical, disintegration being accomplished by means of a grindstone. A large volume of empirical research underlies the standardization of these processes throughout the American pulp and paper industry. There is a great need, however, for more fundamental information on the physical and chemical laws involved in pulp production by these standard methods than yet exists. Such objectives require intensive and continued research, which will coordinate knowledge of raw materials and chemical reagents with a fundamental picture of the reactions occurring in the pulp digester and of the effects of the disintegrating agency, such as the grinder stone. Studies in connection with both the chemical and the mechanical processes have resulted in material improvements, with results in increases of yields and improvement of pulp quality. However, only a beginning has been made, and immense returns should result from a continuation of this line of effort.

NEW PROCESSES

Studies of established processes logically lead to the development of modified or new processes. A recent step in this direction is the replacement of the lime in the normal sulphite method by soda or ammonia, resulting in the extension of the application of the sulphite process to more resinous species. This development has required the working out of a recovery system which will return the more expensive chemicals cheaply and at the same time alleviate a serious situation in stream pollution which now confronts the sulphite pulp industry and is a menace to aquatic life in our lakes and streams. Increases in the quantity of pulp returned per unit of wood have been effected through new semichemical pulping processes, which are combinations of chemical and mechanical action on wood. Whereas the standard chemical methods return only about 40 to 50 percent of the wood as useful fiber, the new methods return from 55 to 80 percent. A so-called semi chemical process using neutral chemicals, a semisulphite process using acid sulphite liquors, and a semisulphate process using alkaline reagents have all been developed in the course of work on this problem. On account of their high noncellulose content, the semichemical pulps are unbleachable by present methods and are limited in their application to light-colored woods or to the production of pulps in which color is a secondary consideration. Even under these limitations, however, the processes are finding their way into important commercial use.

PULPING NEW SPECIES

The need for extending the range of species for pulping has long been recognized, and a systematic survey has been conducted by the Forest Service covering about 100 American woods as regards their adaptability to standard pulp-manufacturing processes. Comparative data have been compiled as to yields, chemical consumption, bleachability, and other factors of pulp production from the various species, but the information is necessarily limited and somewhat in the nature of a "base line" for further intensive studies. The specific characteristics and economic importance of a given species determine the special studies to be undertaken.

The principal weakness disclosed in previous efforts to improve the pulping and papermaking status of particular species has been a lack of what may be termed fundamental information—lack of accurate knowledge of the chemical composition and minute physical structure of the wood, of laws underlying the behavior of pulps in processing, and of the basic factors in paper manufacture. A great mass of empirical data has been built up at the Forest Products Laboratory and at the mills that is applicable to a given species or a given process, but basic information of general application is largely lacking. Work to supply this need is going forward, but it should be greatly increased.

From the standpoint of regional distribution, various types of species have to be considered. In the Northeastern and Lake States, the prevailing softwood types—spruce, fir, and hemlock—have been the mainstay of the American wood-pulp industries, and the direction of progress in the utilization of these species lies in the improvement of the present standard pulping methods or the discovery of new processes that may increase yields and cheapen production. The pines and other species high in resins and extractives that are found in this region offer the same problem as they do elsewhere, namely, how to convert them cheaply into light-colored papers of general utility. The stands of second-growth hardwoods (made up largely of maple, birch, beech, and aspen) that have sprung up following the logging of earlier stands of pulpwood and saw timber throughout a vast acreage in these regions are a potential source of pulpwood. They are of small diameter and of very inferior commercial value at present except for limited uses in soda and mechanical pulping. A much more important use for them is visualized in the form of sulphite or other pulps of wider usefulness and value. Experiments on these lines have been carried forward with considerable success, but the short fiber of the hardwoods still militates against their use in strong papers. It has been shown recently, however, that in the grinding of hardwoods, a proper dressing of the stone surface will accomplish disintegration of the wood with minimum destruction in the fiber length, thus resulting in improved pulps. It is likewise indicated that the high pentosan content of these species may be utilized, if retained in chemical pulps produced from them, to produce much stronger papers than has hitherto been thought possible.

A vigorous and growing pulp industry exists on the west coast. The bulk of the raw material used is western hemlock, which enters into a large production of newsprint, wrapping, and other papers. In this region the utilization of sawmill waste is an outstanding feature, but certain major problems of integration between woods operation, sawmill, and pulpmill remain to be solved. Douglas fir, for example, stands at the top of western lumber production. Its immense cut is attended by immense waste, estimates indicating that, in an average year's logging, 6 million cords of material of pulpwood size or larger is left in the woods unused. This amount, if it could be converted into pulp, would nearly duplicate the present annual pulp output of the country from native sources. If even a third of it could be profitably pulped, American industry would have an immense resource of cheap raw material with which to combat foreign competition, and a commensurate value would be added to our national income. An approach has been made toward solving this problem. One mill in the Northwest is successfully producing bleached soda pulp from Douglas fir for use in book and tablet papers, and several of the sulphate mills in the same region are consuming small amounts of mill waste in the production of kraft papers and kraft boards. The quantity of material thus utilized, however, is insignificant in relation to the available supply and reflects certain difficulties in the pulping of Douglas fir which are the subject of investigation at a number of sources. Some success has recently resulted from modifications of the standard sulphate process by which stronger and better-bleaching pulps have been made, but much remains to be accomplished in this direction.

Additional research on the production of sulphate, sulphite, and mechanical pulps from western hemlock and from a large number of other western woods which hold special promise for papermaking purposes is needed to place western pulps on a full competitive footing with the imported products in the Nation's markets. Among the western species important in this respect are California white fir, ponderosa pine, Sitka spruce, lodgepole pine, redwood, and western larch.

In the South the various species of yellow pine hold the premier position in both lumber and pulp production. Nearly four fifths of the total capacity of southern pulp mills (1 million tons annually) is devoted to producing, from pine, pulps of one main type—unbleached sulphate or kraft. The successful conversion of these difficult resinous species is itself a triumph of research and experiment, but research may have here a more far-reaching result. This is nothing less than to establish in the South the final and perpetual margin of independence for the United States from foreign paper imports.

The South has more than 100 million acres of cut-over pine land which, given proper forest management, is conservatively estimated as capable of producing from one half to 1½ cords of wood per acre per year—a sufficient volume in the aggregate to match our present pulpwood consumption 5 or 6 times over. The problem is, from this potential pulpwood supply, to develop papers of the types required in our national commerce.

Starting with the established fact of a large southern pulp production, the Forest Products Laboratory has evolved a modified kraft process by means of which most resinous species can be converted into strong, light-colored multipurpose pulps. Whether the economic trend will carry this process into large production at an early date or whether a still cheaper and radically different process will find ultimate adoption cannot be foretold in the present state of affairs, but at least a beginning has been made toward solving the problem of diversified southern pulps. Furthermore, by taking advantage of the fact that young-growth slash pine up to about 25 years of age is free from heartwood and is comparatively light-colored, both of which factors are favorable to the application of the sulphite and mechanical processes, there appears a possibility of developing a pulp suitable for newsprint, cheap book, magazine, tablet, light-colored wrapping, and similar papers. All of these types of papers have been produced experimentally from mixtures of sulphite and groundwood pulps from young slash and shortleaf pines. Young growth from other species can probably be similarly used.

Certain southern hardwoods are also apparently potential sources of pulp and paper. Black gum, for example, has been proved to be an excellent base for sulphite or semichemical pulps possessing potential usefulness as a raw material for newsprint as well as for fine papers.

The realization of improvement in use of species now used for pulp or the increase in the number and extent of species which may be used in pulp and paper products must be based on a varied research attack. The following avenues are suggested;

FIBER PROCESSING

Under the head of fiber processing are included the operations of bleaching, beating, loading, sizing, coloring, refining, and any others incidental to converting a pulp into a stuff prior to its run over the paper machine. Each of these operations is virtually a separate field of technology, in which research and long experience have developed the art to varying degrees of excellence. Continued and systematic research is needed to secure higher and more uniform standards of quality, strength, color, and sheet formation.

Fundamental and detailed investigations of the bleaching process have been carried on for a number of years. The several aspects of the problem studied include the effects of temperature, chemical ratio, and consistence upon rate of bleaching, composition, yield, and final color of the pulp. The objective of all such work is to place the bleaching operation on a basis of rational procedure and predictable results and to clear up the confusion, uncertainty, and empirical opinion that has quite generally made bleaching a craft mystery instead of a definitely controlled technical operation. Commonly in commercial operations the pulp is cooked so thoroughly that only small amounts of bleach are required. A thorough investigation is badly needed as to the possibility of modifications of both cooking and bleaching to give higher yields and whiter and stronger pulps. Some progress has been made in this direction through the development of two-stage chlorination bleaching procedures. The further commercial development of such methods, particularly as applied to the pine pulps, would greatly stimulate the use of these pulps and would distribute pulpwood demand more widely.

Research on the beating of pulp has thus far been limited mainly to attempts to place beating equipment under control, so that the operation could be performed in the same way on any given pulp. Methods of really measuring the effects of beating are lacking and must be developed. It is not even known with certainty whether "hydration" as known to the paper maker is a chemical or a mechanical effect.

PAPER MACHINE OPERATING FACTORS

The best-directed efforts to produce a pulp that will make paper of excellent quality can be defeated by faulty machine operation. Tests indicate, for instance, that the strength of sheets can be lowered 33 percent and porosity increased 100 percent by draw manipulation alone. In order to put the papermaking procedure on an engineering basis as free as possible from purely empirical practice, research looking to the isolation, measurement, and control of the machine operating factors is essential.

This is no simple task. At least 75 independent or dependent variables have been identified on the paper machine, a few of the more important being consistence of stock passing to the wire, relative speed of stock and wire, effect of stock temperature, hydrogen-ion concentration of the stock, rate of drainage to effect formation, couching pressure, rate of moisture removal in presses, drying rate, amount of draw, and calender pressure.

MILL WASTE UTILIZATION AND WASTE PREVENTION

Large opportunities for operating economies and increased returns await the work of practical research in the utilization of wood-room wastes and mill effluents. Bark has ordinarily been a total waste in pulp manufacture. A small amount of investigative work has been done to develop methods of using bark for fuel or for special products. There is need for much more. It is estimated that wood fiber to a value of $10,000,000 goes down mill sewers annually, suspended in the "white water" discharge. This waste would not occur in the line of ordinary business if the over-all economy of saving it could be demonstrated in general practice. A third obvious line of economy in production is the utilization of spent liquors. The savings possible in the reuse of waste sulphite liquors in a second pulping treatment have been partly demonstrated, and still greater gains lie in the possible utilization or recovery of sulphite liquors now discharged, containing as they do all the chemicals of the pulping reaction and a full half of the raw material.

Determined efforts should continue toward the elimination of fiber losses due to the decay of pulp and pulpwood. The latter is subject to deterioration from the time of cutting until it is delivered to the grinder or chipper for conversion into pulp. Under commercial conditions of handling, deterioration of wood is particularly rapid in the second and third years of storage. A further source of loss is the reduction in quality due to the deterioration of the pulp into which the wood is converted. While the development of antiseptic chemical treatments and of improved methods of handling pulp and pulpwood have aided considerably in reducing losses, work is still needed to insure commercial applicability of research findings. In addition, the use of new woods and the changing conditions and methods of handling continue to introduce new problems of deterioration that demand study.

WOOD—ITS STRUCTURE, COMPOSITION, AND PROPERTIES

Wood is both a finished natural product and a storehouse of raw materials. It is a fibrous aggregate containing cellulose and other carbohydrates, lignin, and extractives, combined in variable quantities and arranged in a complicated and variable microscopic structure. There are 150 important species of wood in American forests, each differing from the others in structure and properties, and each varying within itself to a considerable degree. The chemical composition of wood substance, the arrangement of the constitutent parts in the wood cells, the size and spacing of the cells, and the variation of all such characteristics according to species and growth conditions determine the usefulness of wood as such and its potentialities of conversion into other products. A scientific understanding of these matters opens the way to success in the silvicultural control of the material and its properties, in its selection, its seasoning and handling, its impregnation with preservatives, its use in construction, and its conversion into pulp and other products.

To visualize and emphasize the complexities and importance of research that lies ahead in these fields something of the facts at present known and the main lines of further study required will be briefly reviewed.

STRUCTURE OF WOOD

The structure of wood is so complex and variable that an adequate conception of it cannot be conveyed in a few words. Essentially it is a cellular structure, but there may be several different kinds of cells with different arrangement and different means of intercommunication. Most of the cells are arranged longitudinally, parallel to the tree trunk, but some extend radially. Beyond this cellular structure, plainly visible under the misroscope, are smaller structural units. The cell walls are made up of concentric layers, which in turn are composed of fibrils arranged spirally. The fibrils are the smallest units that become evident through any simple mechanical disintegration, but by careful chemical treatment they themselves may be subdivided into spindle-shaped "fusiform bodies" and the latter into minute spherical units. The spherical unit—the ultimate visible component of the cell wall—is about one hundred-thousandth of an inch in diameter, and beyond it the microscope cannot penetrate. It is possible, however, by indirect methods using the ultracentrifuge and the X-ray, to determine the approximate size and arrangement of submicroscopic units.

The arrangement of these various parts to form the cell wall, the shape and size of the various cellular structures, and their arrangement and mode of joining to form the wood determine completely the gross mechanical properties of the material. The submicroscopic units and the peculiar attractive forces between them give wood its colloidal properties, such as hygroscopicity. This absolutely basic field of wood research is largely unexplored. It abounds in hypotheses of colloidal behavior which await experimental verification and correction. Other more specific structural research is concerned with the means of communication between the cells. The cell cavities are separated by thin pit membranes through which there are openings of submicroscopic size that can be measured only by indirect methods. The number, size, and location of these openings, together with the colloidal properties of the membrane itself, are thought to control all natural or artificial movement of liquids within the wood, but no satisfactory theory of their action has as yet been worked out.

Even in regard to those types of structure that are readily visible in wood sections under the microscope, quantitative statistical information that has a realistic bearing on the properties and utilization of wood is very meager. Much more research is needed before the picture of wood structure and substance as an industrial material can compare, for instance, with that which the metallurgist has obtained for such materials as steel and copper.

CHEMISTRY

As to the chemical composition of the various structural units of wood, information is likewise far from complete. It is known that the structural units of the cell wall are essentially cellulosic in composition. It is thought that a small amount of lignin is incorporated with this cellulose structure, but the details of its distribution there are not known. Lignin, however, comprising approximately one third by weight of all wood substance, is the main constituent of the cementing layer between the cells. There is present in the wood a considerable percentage of carbohydrates other than the cellulose whose location in the structure is unknown, and finally there are extractives or infiltrated substances that are variously distributed, either in specialized structures such as the resin ducts of certain species or in the cell cavities, or more or less evenly disposed throughout the cell wall.

As distinguished from the chemistry of its minute structure, the general chemistry of wood is fairly well known in terms of the gross chemical groupings already stated. But even in these limited terms there is little statistical information on the variations in composition between species, within species, or within single trees. Moreover, much additional information is needed as to the chemical composition of the main groups, cellulose, lignin, etc. The term "cellulose" as used here comprises a group of similar carbohydrates that make up about 60 percent of the weight of dry wood. Only about three fourths of this "cellulose" is true cellulose, however. The remainder is made up of different sugar units put together in somewhat less stable form, and our little knowledge concerning their constitution and the nature of their combination is entangled with a mass of speculation. Even less is known about the group of carbohydrates not closely associated with the cellulose that make up about 5 to 10 percent of the wood.

Lignin remains an unsolved mystery. Many isolated facts are known in regard to its chemical characteristics, but they do not form any clear or connected picture of its constitution. Probably it is not a single chemical substance but rather a loose grouping of similar substances in variable proportions.

The extractives are really matter outside the mechanical structure of wood, but they are important in connection with many of its properties. Color, odor, and durability are basically dependent on extractives, while pulping, painting, gluing, and even strength properties are considerably affected by them.

They vary widely in both amount and composition, such different classes of chemicals as resins, terpenes, tannins, gums, carbohydrates, and dyestuffs being common amongst them. While the detailed composition of the extractives in some few species is well known, it is incomplete or entirely lacking in most.

MECHANICAL AND PHYSICAL PROPERTIES

The mechanical characteristics of wood—its strength, elasticity, and related properties—depend on the physical properties of the structural units, their arrangement, and mode of joining. The structure of wood is so complex, however, and the structural units so small, that the mechanical properties have not been actually determined in any such manner, but instead have been directly measured by standard engineering testing methods. The various important strength values of the 160 principal American woods have been determined and general rules developed for the effects of density and moisture content. This kind of information is fairly complete, although more information on the range of values as well as the average values, and on second growth as well as virgin timber, would be desirable. There are also two important commercial properties, resistance to abrasion and workability under tools, for which no figures are available.

The information that we possess as to strength properties has been collected with only incidental reference to structure; the direction (longitudinal, radial, or tangential) in which the force was applied was commonly known, and one structural characteristic, density, was always determined. The finer details of structure were not determined, however, nor were the tests designed to show the effect of structural variations in any minute degree. This kind of work, only recently undertaken, has naturally begun with the influence of the largest unit structures, the two layers of the annual ring, spring wood and summer wood, upon the strength of the piece. Much remains to be done even in this field of gross structure, and then more complicated fields of smaller units, such as the thickness of the cementing layer of lignin and the slope of the spiral angle of the fibrils, must be developed before scientific knowledge of the relation between structure and strength can be considered at all adequate.

There are other types of scientific details in wood mechanics, knowledge of which would be very desirable. For instance, wood is not truly elastic but has a tendency toward gradual plastic yielding, and it is important to know whether the plasticity has its origin in the cellulosic fibers, in the lignin cement, or in shear between the fibers.

Other physical properties as distinguished from the purely mechanical are also obviously dependent upon the minute structure of wood. Among these, heat, acoustics, electrical properties, and hygroscopicity are outstanding. None has received thorough or systematic study.

The handbook figures for heat conductivity of wood are incomplete as to species, moisture content, direction of the grain, density, and temperature boundaries. A few accurate determinations have been made on the effect of some of these factors, but not enough to give the architect or engineer the specific information he requires in order to determine what wood to use or whether to use wood. Heat conductivity also has important bearings on the fire resistance of wood in large sizes, on wood distillation processes, on the preheating preceding impregnation treatments, and on other important industrial operations. What little has been accomplished in theory and technique has not been adequately applied to wood as a construction material where control of acoustic properties is required. Further knowledge of the electrical properties of wood might seem to be unimportant in direct application to uses of wood, since wood in its unmodified state is not reckoned as either a good conductor or a true insulator. Research on electrical properties has, however, been of great assistance in solving other problems, such as the measurement of moisture and the determination of the submicroscopic pore volume of wood, so that, indirectly at least, further knowledge of electrical properties would be of value.

The great importance of a complete and detailed scientific knowledge of hygroscopicity is evident from the fact that it affects every other physical and mechanical property of wood. The water in wood occupies two different kinds of cavities, the microscopic cavities and the extremely small spaces between the submicroscopic structural units. The larger cavities remain as cavities of the same size whether they contain water or not, but the smaller cavities decrease in size according to the amount of water removed from them. The lowering of the vapor pressure of the water in the latter is the basis for the hygroscopic property of wood—its ability to absorb water from the air—and their change in size is the basis for the swelling and shrinking of wood with change in content of hygroscopic water.

This hypothesis of the cause of hygroscopicity and shrinkage is tentative and imperfect because there are so few facts from which to develop it. For a satisfactory understanding of these phenomena, intensive research is required on such diverse subjects as the hygroscopicity of different components of wood, directional shrinkage of the structural units, hysteresis effects, absorption of other liquids than water, and diffusion of hygroscopic water.

GROWTH CONDITIONS

The proper and satisfactory use of wood has had to depend on selection from a widely varying natural product in order to obtain the different kinds of material required. In this respect it is fortunate that wood is a widely varying product. From another point of view, the use of wood would be less a problem if its properties and minute structure could be controlled in somewhat the same manner as the metallurgists controls the quality of metals in manufacture.

Such control of the raw material, wood, lies in controlling the conditions of its growth. Distinctive species characteristics cannot be changed, but within the ordinary variations of a species wood of more uniform and more desirable properties can be grown.

The existing information on this subject is very slight in view of the wide field to be covered. There are so many species, properties, and growth conditions that the complete correlation of all or even the most important of them will take a large amount of research. It has been found that with longleaf pine the proportion of summerwood to springwood (and hence density and strength) can be varied within limits according to the amount of soil moisture available. In second-growth southern pines the increased rate of growth that accompanies increased openness of stand causes a decrease in the density and strength of the wood, and the indications are that this relationship holds for the softwoods as a class. In hardwoods, on the other hand, it appears that reduction in strength may occur when the rate of growth is slowed down by crowding of the stand. Thus some of the most readily controlled growth conditions are found to have important effects on wood properties.

The effects of growth conditions are brought about through the physiological processes of the tree, which must be much better understood in order to lay a proper scientific foundation for further work. The source and nature of the food supply, its elaboration into intermediate and final products, its translocation to point of final use, the transpiration process, storage of reserve materials, and moisture and temperature limitations are some of the important physiological factors about which the existing information is fragmentary.

The special physiological processes involved in resin formation are of great importance in connection with the production of turpentine and rosin from longleaf and slash pines. Research on the development of the resin ducts in response to the wounding of the tree has already assisted in improving chipping methods so that better yields can be obtained with less injury to the tree. Further improvements depend on more detailed knowledge of the physiology of resin formation.

WOOD-DESTROYING ORGANISMS

There is another type of fundamental research that is not concerned directly with wood but instead with the various organisms that attack wood under certain conditions of its use. The three principal groups of such wood-destroying organisms are the fungi, the insects, and the marine borers. The fungi are responsible for the well-known decay and staining of wood, while insects and marine borers destroy wood in the course of using it for both food and shelter. Further improvements in methods of protection against these organisms require a fuller knowledge of their life history and habits, and especially of the conditions favorable and unfavorable to their attacks on wood. It is known, for instance, that wood may be too wet or too dry for wood-destroying fungi to attack it, but the limits of moisture control between which they are active are not known with any accuracy.

Such fundamental biological research may have fairly direct practical application, since many if not most of the difficulties with these organisms are caused by faulty practice in cutting, manufacture, or storage of the wood or in the design or condition of use of the final product—faulty practice that can frequently be improved or perfected simply and cheaply when there is sufficient knowledge of the limitations of the organisms. Biological research is especially important with fungi, because of the multitude of species that attack wood and the great variation in their characteristics.

Biological research on wood-destroying organisms may also be of value for the purpose of producing chemicals from wood. Molds and bacteria have been recently found that under controlled conditions produce acetic acid, lactic acid, ethyl alcohol, and other higher acids and alcohols from cellulose, and it is possible that similar products could be thus obtained from wood cellulose or direct from wood. Certain organisms attack lignin but, so far as it is now known, without forming useful products.

FUNDAMENTAL RESEARCH AND UTILIZATION PROBLEMS

Fundamental research on wood structure, composition, and properties is of controlling importance to improved wood utilization and to studies having direct practical applications. The relationship is obvious. For selection of material, knowledge of wood structure and its effects on strength and physical properties will give a scientific basis far in advance of existing standards. In the many uses requiring modifications or adptations of the material, such as impregnation, gluing, and painting, a knowledge of the cell and its parts and of the movement of liquids from one part to another will make possible better, more economical, and more efficient processing and better service of the product.

An adequate knowledge of the chemistry of wood is necessary for the development or improvement of chemical processes of wood utilization, including the manufacture of pulp, paper, rayon, and plastics. In this field lie the greatest possibilities of new wood products for new uses. Full understanding of the chemistry of wood as related to biological factors opens the way to processes of conversion that may prove cheaper and more efficient than any now known.

In brief, it is through the methods of fundamental research, largely neglected hitherto as far as wood is concerned, that we must look for future significant progress in technical guidance to improved products and practices and for the development of new products. No one can gainsay the effectiveness of such research until the undiscovered world of wood fundamentals has been explored. To this end the concerted efforts of the chemist, the physicist, the biologist, the bacteriologist, the engineer, and the silviculturist must be intensively applied, with all the tools of modern science such as the ultracentrifuge, the X-ray, and the ultraviolet ray, and all the adptations of the new instrumentalities that research is learning to effect in the sphere of atomic behavior.

COOPERATION IN FOREST PRODUCTS RESEARCH

On account of the many fields in which forest products research is needed and the large and urgent problems remaining unsolved in each, it is obvious that the work ahead presents a responsibility for many agencies. By no means should it be considered the task of any single group or organization. The concerted and best-directed efforts of all agencies that have a defined interest in the forest program is called for. This means full participation not only by the Federal and State governments, colleges, and endowed institutions, but also and especially by private industry concerned with the manufacture, marketing and use of forest products.

The manufacture and distribution of forest products is all in private hands. Many concerns are too small to engage in the research necessary for highly efficient operations, but many are large and have obligations which are now being met only in small part. The competitors of wood, by using research, force similar action upon the forest industries. The private operator cannot depend upon others for all the research he will need. Research organizations sponsored by industry cannot be created or developed too rapidly.

The States should make a large contribution to forest products research because of their expanding ownership of forest land, which has already reached millions of acres in State forests and other holdings. In addition, practically every State has its local forest production and marketing problems which it cannot expect the Federal Government or any other agency to solve except in small part. These include the local problems of unorganized small producers and owners unable to support research except through their contributions to the public taxes. The reasons for a substantial contribution by the States are much the same as in agriculture, and in fact the management and profitable conversion of the farm woodlot is in one sense a promising but largely undeveloped form of diversified farming.

State universities and State agricultural colleges, even though they contain no forest schools, can and should be engaged in one or more phases of forest products research in their engineering, biological, and chemical laboratories. What most if not all the forest schools in such institutions need is larger faculties, from the standpoint of investigative work alone. It would be an excellent thing if all such forest schools could have at least one man with full time or practically full time and suitable equipment available for products research.

The Federal Government already makes a relatively large contribution to forest products research, and a question may justly be raised concerning the obligations of the Federal Government which would justify any large increases.

Many phases and characteristics of the forest utilization problem of the United States are interstate or national. Everyone uses wood directly or indirestly, regardless of the accident of residence. Many phases of better utilization and waste prevention are national problems along with timber growing. The multitude of small manufacturers and small users, including farmers, involve exactly the same considerations as in agriculture from the research standpoint. The national distribution of our pulp and paper manufacture, which would relieve over-centralization in one or two regions, is merely one of a large number of problems which are national or regional, or both. On a realistic analysis, the continued and increased participation of the Federal Government must be taken for granted in any far-reaching program of research aimed at stabilizing and expanding wood consumption in the United States. Government pioneering and success in forest products research, particularly by the Forest Service, stands as an accomplished fact.

The opportunities and needs of endowed universities with respect to forest products investigations are similar to those of State universities or agricultural colleges. Larger faculties and equipment are needed, partly for more effective instruction but chiefly to permit more research. In the various departments of endowed universities with forest schools, and likewise in universities which do not contain forest schools, there is still a very large opportunity for faculty or graduate-student or fellowship research on a wide range of forest problems. If such institutions will encourage research in forest products they can in the aggregate contribute materially to our progress in forestry.

Several research institutions, such as the Mellon Institute and the Institute of Paper Chemistry, already include in their investigative field one or more phases of the forestry problem. The field covered by such institutions should be broadened and the number should be increased. They can be assured that almost anything in forest products research which they undertake will be of benefit directly or indirectly to forestry, and hence to the public welfare.

In brief, there is room and need for the intelligent effort of all agencies, public and private, in the too-much neglected field of forest products research. Cooperation, the broadest possible interchange of information, and avoidance of overlapping effort should be the keynote. Each research agency or class will make a more or less distinctive contribution in this research structure. Private owners and industry will concentrate chiefly on their own localized problems and on the application of more general findings to their conditions and requirements. The States will necessarily work in part on somewhat more generalized problems, but ordinarily not beyond those peculiar to their own territory. An important State function will be to serve large numbers of small owners and operators who cannot be expected to support forest products research except through taxation. State institutions should also work on those fundamental problems which underlie their own needs. The Federal Government must attack regional, interstate, and national problems, and many phases of fundamental work. The national forests alone place a heavy obligation for forest products research upon the Federal Government. Endowed institutions will in most cases work on selected problems or some phase of fundamental research.

MEETING THE CHALLENGE OF CONSUMPTION TRENDS

The measures advocated in the foregoing constitute a plea and a program for placing the whole structure of forest markets on a revised and modern basis of consumer-service and continuing supply.

It cannot be denied that in certain fields of forest consumption the recent trends, aggravated by depression, have been discouraging to producers. They have been prolific of waste, excessive competition, and reckless liquidation of holdings. The situation presents obvious problems which are of fundamental importance to the future of commodity forestry.

On the other hand, it is submitted that changes in demand are to be recognized, not combated. Old-fashioned exploitation of what were formerly "exhaustless" timber resources is not and cannot be the solution of the marketing problem, as both forest demand and forest supply enter upon the modern era and modern conditions. It is imperative that costs within the industries be lowered, to give the consumer the benefit of economical and abundant products and at the same time to cure the ills of unprofitable production and management; that the quality and service properties of the products be largely improved and better discriminated, to insure maximum satisfaction in use; that the development of new products be pushed forward to take full advantage of the tide of modern demands and preferences; and that sales and promotion policies be intelligently and aggressively directed in relation to these same objectives.

Some of the ways and means of meeting the modern challenge have been set forth with at least sufficient clarity, it is hoped, to indicate the direction of progress. It is believed that management and marketing activities may well be concentrated with special reference to transportation costs. The costs of raw material and manufacture should be reduced and quality of output improved by selective logging, and the productiveness of stands should be extended through management for sustained yield. In line with technical efficiency in the use of materials, the trend toward integration of forest-using industries in favorable locations should be encouraged, while wastes in all departments must be further reduced. Production from small holdings must be improved and adjusted to meet the standards of orderly manufacture and marketing, and merchandising must be activated on the modern plane of quality standards and technical requirements.

The apparent "encroachment" or "intrusion" of other materials in fields of wood use has been shown to be an inevitable expression of the modern age and the eagerness of consumers for new and improved products and services. The need and the responsibility for more scientific and technical research in wood and its products have therefore been specially stressed. Some of the more obvious and urgent objectives which research should follow have been pointed out—better construction and fabrication, unit construction, better treating, coating, and gluing processes, better conversion and harvesting, keener selection and grading, the improvement of pulping processes and machine operations in paper manufacture, the development of plastics and other new and special products, basic and fundamental studies of the nature and minute characteristics of wood, and the cooperation of all agencies, commercial and public, in the prosecution of these and allied lines of investigation.

By girding themselves to meet modern demands efficiently, forest industry and forest ownership can look forward to a continued place of major service in the country's economic life. The public has lifelong need for, familiarity with, and attachment to wood and wood products. The Nation has a vast program of forestry at stake in the trend of wood use. The fiscal stability of local governments is bound up with profitable use of the land. The weight of public preference will be a mighty factor that may well be cultivated in stabilizing and enlarging forest consumption and in safeguarding forest markets. It may be counted on to give wood a "fair deal." In return, forest industry must make sure that wood shall meet a high standard of expectation and performance, and that forest resources shall be constructively used and the supply continuously developed in accord with the general welfare.

PROTECTION AGAINST FIRE

By E. I. Kotok, Director California Forest Experiment Station, Evan W. Kelley, Regional Forester, Northern Rocky Mountain Region, and C. F. Evans, District Forest Inspector, Division of State Cooperation, Branch of Public Relations

CONTENTS

	Page
Brief review of fire situation	1395
Objectives in fire control	1397
How closely have the objectives been reached?	1400
Basic needs in a national fire-control program	1403
The essential parts and functions of an adequate fire-control organization	1405
Present expenditures for fire control	1407
Additional expenditures needed	1409
The immediate financial program	1412

BRIEF REVIEW OF FIRE SITUATION

The prevention and control of forest fires is a basic requirement in forestry, whether the purpose of management is timber production, watershed protection, or game and recreational development. American forests in every region show the adverse effects of past forest fires, in depleted and decadent stands of the virgin forest, in deteriorated and denuded condition of cut-over lands, in the impaired condition of important watersheds, and in the destruction or marring of scenic values and the destruction of wild life.

There is abundant evidence in every forest region that repeated fires, through an imperceptible process of attrition, have reduced forest stands and in many types the loss has been one third or even one half in value or volume over extensive areas. In some instances repeated fires have converted valuable conifer forests into brush fields, and important hardwood types into ragged forests of unmerchantable trees. The destruction that follows a spectacular crown fire, which takes everything in its path, is readily recognized. The less spectacular light surface fire, if occurring frequently enough, may approach the crown fire in destructiveness to ultimate forest values. In many regions, tree-killing insects and wood-destroying fungi inevitably increase their activity following forest fires. Frequently the problem of protection against future fires is intensified by the very ravages of past fires.

Systematic and organized control against forest fires was begun in many forest regions about 25 years ago. Considerable progress has been made and partial success attained; but taking all the forest regions together, as reflected in the record for 1926–30, the average burned-over area of 41½ million acres annually on national forests, State, and private lands, fire must be considered as a widespread national problem. In table 1 is given the average annual burn of forest lands in the principal regions. This tabulation in part indicates the relative present intensity of the fire problem. These figures, including more than 37½ million acres burned over annually in the South, over 1¼ million acres in the Pacific Coast region, over 1⅓ million acres in the Central region, and more than half a million acres in the Lake region, conclusively confirm the need for aggressive and intensified effort in curbing forest fires in the United States.

TABLE 1.—*Average annual burn on national forest, and State and private forest lands, 1926–30* [1]

Region	Area burned over	Fires [2]
	Acres	*Number*
New England	95, 884	3, 645
Middle Atlantic	338, 304	6, 557
Lake	563, 536	4, 941
Central	1, 379, 076	12, 527
South	37, 571, 504	117, 778
Pacific Coast	1, 283, 598	6, 898
North Rocky Mountain	283, 882	2, 548
South Rocky Mountain	23, 111	1, 289
Total	41, 538, 895	156, 183

[1] For unprotected private lands in general only rough estimates are available. Such estimates are however, included in this table.

[2] Data on number of fires are based on forest area only and are not directly and proportionally comparable to those shown in table 4, of section entitled "Federal Financial and Other Direct Aid to the States", which are based on a total area, including (in addition to all forested lands) some areas that are nonforested.

While the general situation is still critical, it must be noted that there are regions and parts of regions where reasonably adequate fire control obtains, and steady and favorable progress can be recorded in better-stocked and improved forests as a result of favorable public attitude and systematically organized fire control by States, private timberland owners, and the Federal Government.

No forest regon is entirely immune from fires. There is, however, great difference in the intensity of the fire problem as between regions and even between parts of the same region. Regions or parts of regions where fires are of infrequent occurrence, or where their spread is promptly checked by natural means, requiring no special organized effort, are excluded from this discussion of the fire-control problem, even though in the aggregate they comprise a large area of commercial timberland. On the other hand important watershed areas needing fire protection are included even if they contain no commercial timber. For these reasons the regional and total areas given in this section of the report are not identical with the areas given in some of the other sections. According to table 2, about 63 percent of the total forest and potential forest land requiring protection against forest fires is actually under some form of protection.

TABLE 2.—*National forest and State and private forest areas requiring protection, and total areas protected, by regions (calendar year 1931)*

Region	Area requiring protection	Area with some form of protection
	Acres	*Acres*
New England	28, 201, 000	[1] 28, 614, 476
Middle Atlantic	28, 854, 000	27, 723, 539
Lake	54, 024, 000	[1] 55, 817, 295
Central	53, 005, 000	16, 665, 330
South	206, 321, 000	51, 476, 910
Pacific Coast	75, 979, 000	70, 160, 372
North Rocky Mountain	37, 691, 000	[1] 40, 901, 812
South Rocky Mountain	28, 070, 000	[1] 29, 397, 458
Total	512, 145, 000	320, 757, 192

[1] Excess in area due to discrepancies in reported figures for private forest land.

OBJECTIVES IN FIRE CONTROL

Complete fire exclusion in a forest is rarely attainable. Fires originate from both human and natural causes, and the latter predominate in many localities of the West. The entire elimination of human-caused fires, desirable as it may be, can not be expected in the forest any more than in our homes and cities. Occupancy and use of forest property involves legitimate need for fire, and some fires will escape through carelessness, negligence, or intent. Therefore, in the management of forests, provision must be made to prevent unnecessary fire from starting and for controlling those that through one cause or another do start. What degree of protection against fire is necessary depends on the purposes of management and the damage that may be expected to occur following fires in a given forest type or region.

In other sections of this report the damaging effect of fires on forests is specifically shown. The degree and character of damage varies widely in different forest types. In each forest type, the age of the forest, the amount of debris and slash on the ground, topography, weather conditions, and the season of the year in which the fire occurs, all have a marked influence on the severity of the damage that a given fire may cause. Experience proves that if forests are to be maintained somewhere near their maximum growing capacity, fires must be excluded or held to the lowest possible acreage compatible with the purposes of management for which a given forest is held. One of the major problems in American forestry is to rebuild depreciated forest lands that have already suffered severely from overcutting and burning, and success in recapturing such forest values must be predicated on keeping fires entirely out or within reasonable check. Partial, intermittent, or deferred fire control in forest types where fire damage is severe will at best merely perpetuate partially stocked or unmerchantable forests.

Where timber production is the object of management, it is obvious that a degree of protection must be assured throughout the timber rotation which will prevent seriously reducing the yield or value of the crop. On watershed areas, protection must adequately safeguard the dependent investment throughout its life. In recreational areas, where fires may destroy the unique values, a high degree of protection must be permanently assured even if other resource values would warrant less intensive protection. Fire control is an essential factor in the maintenance of proper environmental conditions for wild life which is one form or another inhabits all forest land.

Protection against fire must be planned on a reasonably permanent basis—half-way measures generally will produce less than half-way results. In most cases, particularly where only a low annual burn can be tolerated, it will be found that the money spent for partial or intermittent protection will be largely a lost and unrealizable investment. The major purposes of management of forest land will be the chief guide in the formulation of the objective in fire control or the limit to which the area annually burned must be held. There are four universal criteria that can be applied as a gage in determining what the objective should be. These are as follows:

1. How much damage will a given fire cause to present and potential timber growth and other forest values?

2. How much damage will a given fire cause to the productivity of the land (the site)?
3. With what degree of difficulty will a forest be restablished after fire?
4. Will future protection be increased in difficulty after a fire runs over the forest?

These criteria, which reflect the major purposes in all forest management, are interrelated and have been used in this inquiry as a device to measure the degree of damage that a given forest type is likely to suffer as a result of fire. In applying them we frequently find, for example, that a mere surface fire may cause the complete destruction of a spruce or white-pine forest. A fire of moderate intensity in the ponderosa pine type will seriously injure the site, wipe out young reproduction, and take some toll of mature timber. In the hardwood forests of the Central States, a ground fire will usually diminish the growth capacity of the forest and stimulate decay from damaging wood-destroying fungi, seriously depreciating the quality of timber. In the longleaf-pine type, fires do far less damage than in the other types mentioned. A fire in the brush-field watersheds of California seriously threatens storage reservoirs, special spreading grounds, and dependent agricultural land for 3 to 5 years, until a new brush cover returns. In a like manner, the damage done by fire to forage and watershed values, recreation values, and wild life varies between regions and even within a region. These varying factors have been taken into account in the determination of the objective in fire control.

Realizing that complete fire exclusion is not a practicable measure and in many instances is too costly, an objective in fire control has been set up for each forest type based on the percentage of the area that may burn over annually without impairing radically the forest values as determined by the predominant purposes of management. This objective of fire control is expressed as the area of allowable burn, and has been determined for each of the major forest types (table 3). It becomes obvious that the absolute acreage burned over in different forest types is not the sole criterion either of the damage sustained or of how nearly the objective has been met. This annual allowable percentage index has been calculated by considering how the four factors influencing damage from fires operate in the different forest types of the United States. Controlled fires used for definite silvicultural or protective purposes are not included in computing the allowable burn.

From these estimates of allowable percentage of burn in forest types it is possible to compute a percentage for each of the forest regions. Obviously, this composite regional percentage is only a very rough estimate of value and a broad indicator of the goal in view to permit a somewhat more general administrative grasp of the fire situation. Such figures, computed separately for the national forests and for the areas outside, are given in table 4.

TABLE 3.—*Indexes of effective fire control for various forest types*

Type	Annual allowable burn	Type	Annual allowable burn
	Percent		*Percent*
White pine	0. 1	Slash pine	0. 7
Spruce	. 1	Sand pine	1
Douglas fir	. 2–. 3	Longleaf pine	3
Larch-fir	. 25	Northern hardwood	. 2
Larch-fir-white pine	. 15	Appalachian hardwood	. 5
True fir	. 2–. 3	Bottomland hardwood	. 2
Ponderosa pine	. 3	Oklahoma hardwood	1
Mixed conifers (Calif.)	. 3	Aspen	. 7
Lodgepole pine	1	Noncommercial forests	2
Jack pine	. 5	Brush and nontimbered	2. 5
Norway pine	. 3	Watersheds	. 4–2. 5
Shortleaf pine	1	Recreation values	0. –0. 5
Loblolly pine	1		

TABLE 4.—*Objectives in fire control on national forest and State and private-forest land, by regions*

Region	State and private areas		National forest areas	
	Area requiring protection	Allowable burn	Area requiring protection	Allowable burn
	Acres	*Percent*	*Acres*	*Percent*
New England	27, 671, 000	0. 16	530, 000	0. 13
Middle Atlantic	28, 485, 000	. 35	369, 000	. 16
Lake	52, 306, 000	. 36	1, 718, 000	. 43
Central	52, 341, 000	. 59	664, 000	. 50
South	202, 904, 000	1. 34	3, 417, 000	. 90
Pacific Coast	41, 720, 000	. 49	34, 259, 000	. 27
North Rocky Mountain	9, 455, 000	1. 05	28, 236, 000	. 56
South Rocky Mountain	2, 194, 000	. 41	25, 876, 000	. 49
Continental United States	417, 076, 000	. 88	95, 069, 000	. 44

The objectives in fire control, as indicated in tables 3 and 4, vary not only from region to region but also for different sections within a given region, as determined by forest type. Thus in New England, whereas only 0.16 percent of the area as a whole can be allowed to burn over annually without seriously or permanently disturbing a growing forest, burns in northern hardwoods may safely reach 0.2 percent, or in noncommercial forest 2 percent. In the South the objective in fire control, expressed as 0.9 percent of allowable burn annually for national-forest areas and 1.34 percent for the territory outside the national forests, may in different types vary from 0.2 to 3 percent. The comparatively high percentage of annual allowable burn in the South is due to the fact that fires in this region affect the forest less harmfully than elsewhere.

As explained previously, these objectives are the best determinable approximations in the light of present information, and are subject to revision as better basic data become available. Differentiations in objectives will undoubtedly be set up as between areas placed under intensive management and culture and those that are to be treated extensively. The trend will very likely be toward higher standards and reduction in the area of allowable annual burn.

HOW CLOSELY HAVE THE OBJECTIVES BEEN REACHED?

The 41½ million acres of forest and potential forest land burned over annually during the period 1926–30, and the 447,000 acres on the more intensively managed national forests included in this total, are startling and alarming figures in themselves. The damage to forest values as a result of these fires can perhaps best be indicated and measured by comparing directly the annual burn and the objectives in fire control set up for each major forest region, as shown in table 5.

Table 5.—*Ratio of actual annual burn to allowable burn outside and within national forests, by regions (average 1926–30)*[1]

Region	Outside national forests	Within national forests
New England	1.84	0.015
Middle Atlantic	2.97	3.78
Lake	[2] 2.70	.85
Central	5.36	1.03
South	14.19	1.02
Pacific Coast	4.96	2.78
North Rocky Mountain	.99	.87
South Rocky Mountain	.56	.70
United States	11.00	1.07

[1] A ratio of 1 or less indicates that objective has been reached.

[2] Data incomplete for certain areas in Wisconsin and Minnesota.

The data briefly indicate that on the 417 million acres constituting the major forest regions, outside of the national forests, requiring protection against fire, 11 times as much damage was done by fire as this area can receive and still retain the desired degree of productivity. On the 95 million acres of national forest land requiring protection as a whole, on the contrary, damage was held down practically to the acceptable maximum. The extremely high ratio (11 to 1) for the areas outside the national forests is due in a large measure to the existence of millions of acres of forest land where, because of lack of funds, no protction is afforded. At the same time, large areas exist in every region where fire-protection work is fairly adequately financed and the results are relatively satisfactory.

Of the territory outside of the national forests (fig. 1) only the South and North Rocky Mountain regions attain their objectives. The forest regions where greater timber values are at stake are burning annually considerably more than the desirable maximum. For example, the South, covering a territory of 206,321,000 acres of forest and potential forest land, is burning over at the rate of 14.2 times its objective, in spite of the fact that the percentage of allowable burn set up in the objective (1.34 percent) is far higher than for any other important forest region. The large area burned over in the South is largely attributable to public indifference to the desire of special groups to fire the woods for one purpose or another, to inadequately financed fire-control organizations, and to the few large sections of the region where no protective effort against fire is being made. But even in forest regions where current expenditures are large, as for example in the Pacific Coast, Lake, or Middle Atlantic, further intensification of fire-control effort is needed if the objectives are to

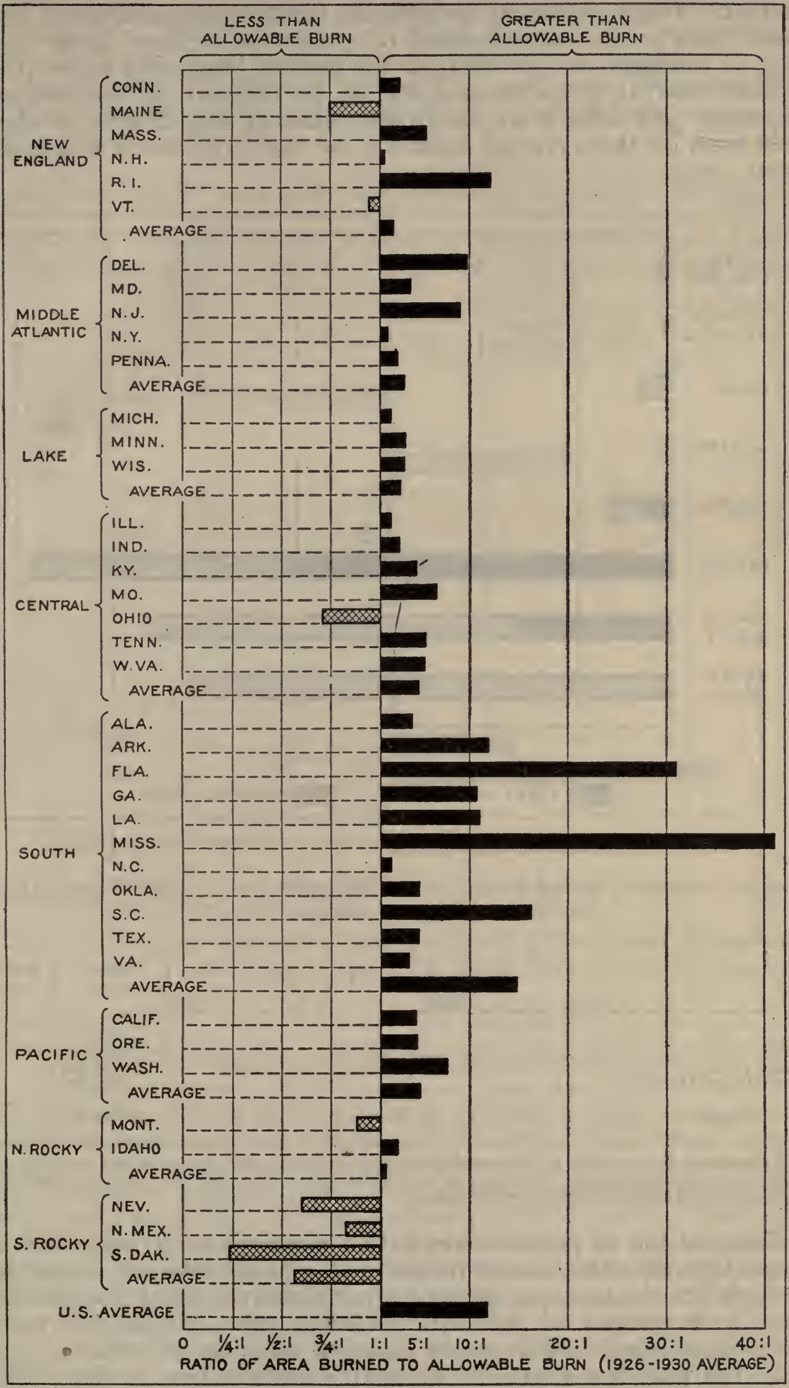

FIGURE 1.—Relation between average annual burn and allowable burn by States, on State and private land. (A ratio of 1:1 or less indicates a satisfactory condition.)

be met. While results on the national forests are on the whole much more satisfactory, examination of groups of critical forest areas (fig. 2) discloses the justification for further intensified effort if the present annual areas burned are to be reduced to the desirable objective. In table 6 are shown the ratios of annual burn to allowable burn on these critical areas for the three regions in which such areas occur.

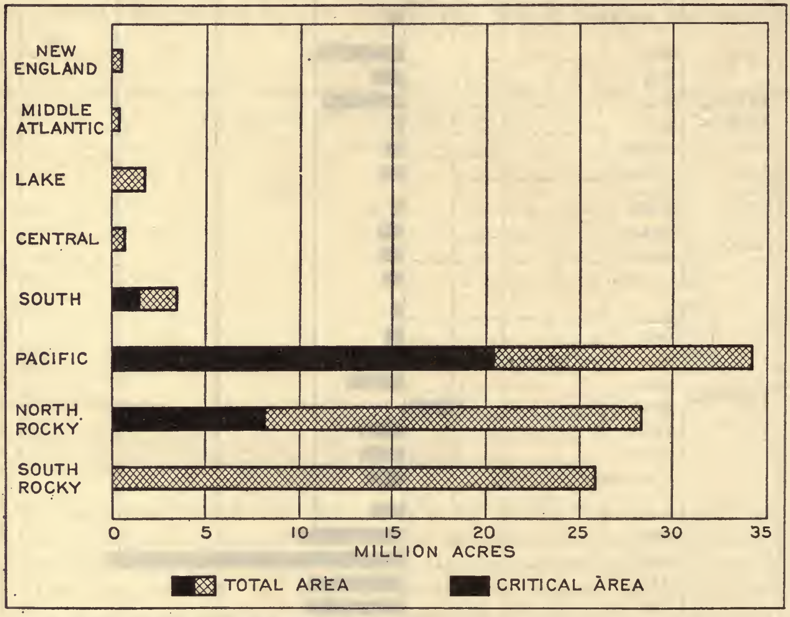

FIGURE 2.—National forest areas needing protection, total and critical areas, by regions.

TABLE 6.—*Ratio of actual annual burn to allowable burn on critical areas* [1] *in the national-forest system (average 1926–30)*

Region	Critical areas	Ratio of burn
	Acres	
South	1,451,884	1.13
Pacific Coast	20,412,000	5.4
North Rocky Mountain	8,165,000	5.5
All areas	30,028,884	4.95

[1] The reference here, as in fig. 2, is to considerable blocks of timber where fire risk is high and need of adequate protection most urgent. Excluded, for the purposes of this discussion, are "spots" or small tracts of high risk, such as may be found in every region.

Thus, of the 95 million acres within the national forests requiring protection, 30 million acres in tracts of considerable size are subject to high fire damage and present an unusually critical fire problem. This 31.6 percent of the national-forest area, during the period 1926–30, suffered 4.95 times the burn set up in the objective.

In the past few years the protective organization in this critical group has been materially strengthened by added man power. improved means and methods of fire fighting, and a road-building program which has made for more rapid and certain suppression of fires. As a result of these additional protective measures a very definite reduction in acreage burned has been accomplished during the past 2 years, and the objectives in fire control have been more nearly approached (fig. 3).

BASIC NEEDS IN A NATIONAL FIRE-CONTROL PROGRAM

The economic necessity for preventing or controlling forest fires is not yet universally recognized or accepted in all forest regions of the United States. In the development of the country, the very process of carving homesteads and farms out of the original virgin forest, the subsequent era of timber exploitation with little or no regard for the destructive methods used, and other unregulated use of our forests have all created an unconscious public attitude of disregard for the forest. Fire was used not only as a means of removing slash and debris but also for the more rapid clearing of standing forests. The habit of firing the woods for one reason or another has persisted in many parts of the United States, although the original purpose or need for doing so as a rule no longer exists. The very extensiveness of the original forests created a false assurance of their inexhaustibility. Thus, through 3 centuries there has grown up a public disregard, dis-

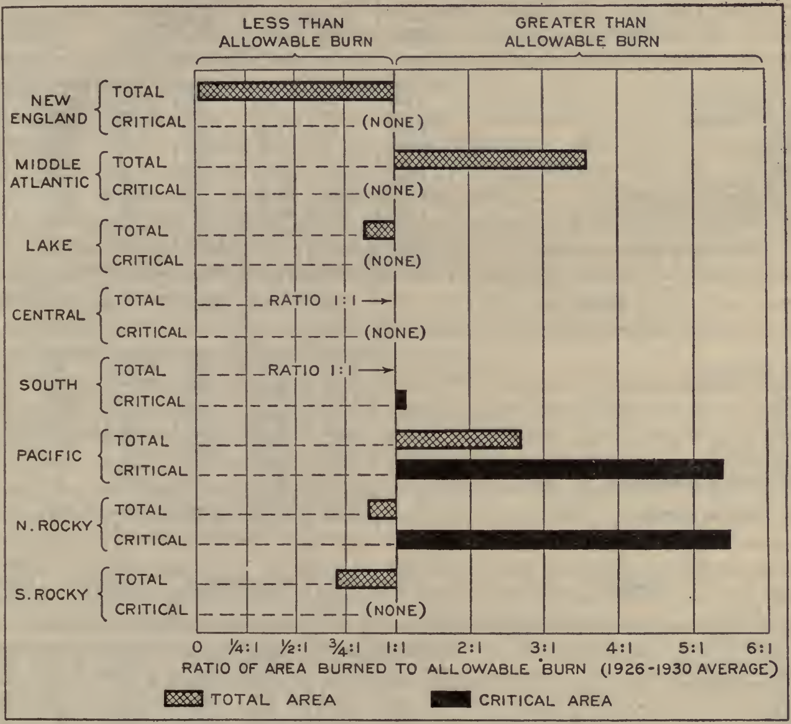

FIGURE 3.—Relation between average annual burn and allowable burn, on total and critical areas of national forests, by regions. (A ratio of 1:1 or less indicates a satisfactory condition.)

interest, and indifference towards the forests. In spite of 25 years of educational effort the number of human-caused fires is still surprisingly high. We are still confronted with a severe handicap in attempting to protect forests against fires, simply because the public has thus far failed to grasp the nature and extent of the protection problem and accordingly has made little progress toward eliminating the causes of fire. Table 7 showing the number and causes of fires for 1926–30, gives definite evidence of this heedlessness.

TABLE 7.—*Average number of fires by cause, national forests, State, and private lands (protected areas only), 1926–30*

Region	All causes	Lightning		Railroads		Campers	
	Number	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
New England	3, 645	25	. 69	683	18. 74	87	2. 39
Middle Atlantic	6, 529	35	. 54	1, 189	18. 21	430	6. 59
Lake	4, 941	69	1. 40	617	12. 49	397	8. 03
Central	2, 882	9	. 31	202	7. 01	222	7. 70
South	16, 114	177	1. 10	833	5. 17	1, 422	8. 82
Pacific Coast	6, 864	1, 612	23. 49	339	4. 94	670	9. 76
North Rocky Mountain	2, 442	1, 527	62. 53	150	6. 14	175	7. 17
South Rocky Mountain	1, 255	807	64. 30	30	2. 39	122	9. 72
Total or average	44, 672	4, 261	9. 54	4, 043	9. 05	3, 525	7. 89

Region	Smokers		Debris burning		Incendiary	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
New England	1, 063	29. 16	555	15. 23	165	4. 53
Middle Atlantic	1, 830	28. 03	820	12. 56	414	6. 34
Lake	1, 318	26. 67	755	15. 28	329	6. 66
Central	431	14. 95	527	18. 29	814	28. 24
South	2, 660	16. 51	2, 327	14. 44	4, 924	30. 56
Pacific Coast	1, 620	23. 60	502	7. 31	907	13. 21
North Rocky Mountain	278	11. 38	92	3. 77	74	3. 03
South Rocky Mountain	208	16. 57	24	1. 91	11	. 88
Total or average	9, 408	21. 06	5, 602	12. 54	7, 638	17. 10

Region	Lumbering		Miscellaneous		Unknown		Man-caused fires
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Percent*
New England	25	0. 69	365	10. 01	677	18. 57	99. 31
Middle Atlantic	40	. 61	614	9. 40	1, 157	17. 72	99. 46
Lake	72	1. 46	637	12. 89	747	15. 12	98. 60
Central	160	5. 55	175	6. 07	342	11. 87	99. 69
South	1, 067	6. 62	1, 442	8. 95	1, 262	7. 83	98. 90
Pacific Coast	337	4. 91	774	11. 28	103	1. 50	76. 52
North Rocky Mountain	40	1. 64	59	2. 42	47	1. 92	37. 47
South Rocky Mountain	11	. 88	42	3. 35	--------	--------	35. 70
Total or average	1, 752	3. 92	4, 108	9. 20	4, 335	9. 70	90. 46

The first task in any adequate fire-control program is to stimulate by carefully designed educational means a proper and sympathetic public attitude towards forest values, and to build up among the leaders of opinion in the community an intelligent understanding of the damage that fires may inflict and the means whereby their destruction may be checked.

The next step in the program, which must be predicated upon an educated public consciousness, involves the enactment of sufficiently stringent local, State, and Federal fire laws providing for the employment of reasonable safeguards in the legitimate uses of fire in the woods and the punishment of carelessness, neglect, and arson. Forest property, whether in private, State, or Federal ownership, must have legal protection against the careless or recalcitrant fire setter. It is true that even the best forest-fire laws are of little consequence unless there is widespread public support for enforcement. But frequently the apprehension of the vicious or careless fire setter will bring forcibly to a community the first gleam of appreciation of the individual's responsibility for care with fire.

In the main, three different types of thought stand in the way of local progress in fire control in each region, and unless they are recognized and dealt with intelligently, all the physical features of a fire-control program, no matter how well conceived, will fail to insure success. There is first the group that definitely approves the use of fire in the woods and shows antagonism to any fire-prevention program. This attitude is usually founded in ignorance of the ultimate effects of burning or else interest is centered on the advantages to the burner without regard for community welfare. Second, is the group that shows no interest in the effort to halt the setting of fires. Third, are those who may, under careful stimulation, become the leaders in the community's fight against fire, but who at present condone fire setting as a necessary or unavoidable evil. Reasonably suitable fire laws are already on the statute books in practically every important forest region. Here and there they require strengthening, but what is needed above all is an urgent demand from the leaders of thought in each community for their enforcement.

To insure continuous and effective fire control on State and private land, the third step required is organic laws providing for active and positive State responsibility for organizing and directing fire-control effort on a State-wide basis. The States that at present are treating fires as a common enemy and taking the full financial responsibility, without dependence on private funds, are generally showing the best results.

The fourth essential feature in an adequate program of fire control is the establishment of an assured and continuous financial support for building and sustaining the protection organization. In all forest regions funds are required for some or all such specific purposes as fire-prevention programs, competent executives, a trained field force; capital investments for roads, trails, fire lines, lookout houses or lookout towers, and other physical improvements; equipment and tools for prevention and suppression of fires; and special workers for suppressing going fires. Fire fighting is a technical task requiring preparedness, specialized equipment, and an effectively trained organization under a high standard of executive direction. It cannot succeed with haphazard methods; with loose organization; with unskilled leaders hurriedly assembled when an emergency arises.

THE ESSENTIAL PARTS AND FUNCTIONS OF AN ADEQUATE FIRE-CONTROL ORGANIZATION

Speed of attack is the essence of successful fire control in city and forest alike. Once a fire starts it increases progressively in size as long as fuel is in its path and weather conditions are favorable for combustion, and the suppression task becomes progressively more difficult, more costly, and less certain. The ideal protection organization is built on the principle that fires be discovered and reported promptly to trained fire-fighting units capable of attacking the fire in the shortest possible time and also of expanding to cope with any fire-control job that may develop. The frequency and occurrence of past fires and the rate at which fires spread, as shown by the fire history of a forest property, determine the number and placement of a mobile man power prepared so to function. Provision also must be made for expanding auxiliary forces to supplement the regular first line of defense.

To determine what form the fire-control organization will take and how intensive it will be, full consideration must be given to the local objective in fire control, the intensity and character of fire risks, density of population, accessibility of the areas of greatest fire danger, and the rate at which fires normally spread in a given forest type. The organization thus perfected will function adequately at critical times and will meet definite time requirements as to the speed with which it is prepared to attack a reported fire. On the basis of present studies, speed-of-attack [1] objectives vary all the way from three quarters of an hour to 12 hours.

Just what happens when a fire starts in any area under organized protection? In a critical western forest region the procedure is as follows:

First must come prompt detection furnished by lookout men stationed on prominent peaks or high towers, or at other fire-observation points. The lookout immediately reports the fire to a dispatcher, who in turn transmits the information to a fireman. To make the report requires an extensive communication system of telephone lines in good working order. The fireman, the first line of defense, must be prepared with tools, equipment, horse, or automobile to proceed at once to the fire over roads and trails. If speed is to be made in reaching the fire the road and trail system must break up the territory sufficiently so that fires can be reached in even as small a time interval as half an hour. If the fire requires reenforcements, trucks and additional tools must be dispatched from supply depots and labor sources over a road and trail system. Then comes the task of actually extinguishing the fire, involving exacting standards of performance and management.

In the East as a rule a less elaborate system is needed because the forests usually are more accessible, man power is more readily available, and the difficulties in the way of suppression are not so great.

West or East, the business of controlling fire must be built up step by step to meet each special need. Men, whether hired or volunteer, must be carefully trained for the specialized jobs of fire prevention, including law enforcement, detection, dispatching, fire fighting, and use of various equipment from the simple shovel, ax, and saw to the automatic pumper, plow or tractor. The men must be keenly interested in their tasks, must be skilled in woodcraft, in firefighting, and must be capable of assembling unorganized crews, organizing and directing them, and putting them to work. A skilled fire-control organization in a single Western ranger district must be prepared to suppress a small fire, a broadside of even 100 lightning fires resulting from one electric storm, or a major conflagration requiring the organization of a thousand men for a week's battle. Above all else a fire-control organization requires skilled and trained leadership of a high degree of executive and managerial capacity. This highly trained organization requires definite physical things if it is to function properly. It needs for prevention, educational equipment; for detection, lookout structures; for communication, a telephone system; for moving its first line of defense, a road and trail system, adequate transportation, and a supply of carefully selected and in part specially designed equipment; for its second line of defense in isolated regions, supply depots with immense stores of tools, food supplies, equipment, pack stock, bedding, cooking outfits, and trucks.

---

[1] Allowable time between start of fire and arrival of forces at fire.

In forest-fire fighting the plan of organization must provide for the peak year and for the unusual month or day when adverse weather whips fires with fury before it. A year or even a 5-year period may pass by during which even an undermanned or poorly equipped organization can hold fire in check and within the objective of fire control. But the test comes in these occasional bad fire days or the critical fire years when the work of many decades in the protection of the property may be wiped out. Thus protection must be planned for at least the average critical year.

The basic needs for adequate fire control may be summarized as:

1. Comprehensive fire-prevention programs designed to create positive interest and active support on the part of the public.
2. State laws, providing direct State responsibility for the protection of State and private forest lands.
3. Local, State and Federal fire police regulations and laws.
4. Continuing appropriations for capital investments in transportation, detection, and communication system until an adequate layout is provided.
5. Annual appropriations for annual carrying charges to provide capable executives, trained personnel, equipment, and labor for suppressing fires.

PRESENT EXPENDITURES FOR FIRE CONTROL

Inherent regional differences, such as the character of the forest, the terrain, the severity of fire weather, and the local public attitude toward forest property go far toward determining the total expenditures for fire control, but great differences in per-acre expenditures are evident in regions of closely similar fire danger and equal forest values. These differences in current expenditures have in many cases slight relationship to the needs of the job, but often reflect either lack of interest of the State and private owner in the necessity for fire control or their financial incapacity to meet it.

In table 8 are given the current average annual expenditures in fire control by major regions, for all lands in State or private ownership. The expenditures per acre were calculated by charging the total expenditures against the total area needing protection, although in some regions, particularly the Central and South, millions of acres are receiving no protection.

TABLE 8.—*Average annual expenditures for fire protection on State and private forest land, and cost per acre, by regions (average 1927–30)*

Region	Total expenditures	Cost per acre
	Dollars	*Cents*
New England	535, 440	1. 94
Middle Atlantic	787, 755	2. 77
Lake	1, 050, 982	2. 01
Central	208, 900	. 40
South	871, 816	. 43
Pacific Coast	1, 368, 131	3. 28
North Rocky Mountain	558, 105	5. 90
South Rocky Mountain	19, 456	[1]. 89
United States	5, 400, 585	1. 29

[1] Incomplete record of expenditure on private land in New Mexico.

Of these expenditures, the cost per acre rather than the total is the more significant figure, because it makes possible a better comparison of unit cost. For the territory outside the national forests, present per acre expenditure is highest in the North Rocky Mountain, followed by the Pacific Coast, Middle Atlantic, Lake, New England, South Rocky Mountain, South, and Central regions, in the order named.

The North Rocky Mountain region on the upper end of the scale (5.9 cents) is spending on its total area needing protection almost 15 times as much per acre as the Central and South. This wide spread between regions is not, as stated previously, due merely to differences in the inherent difficulty of the fire-control job but also, and probably more, to the interest or lack of interest of the private landowner and the State in fire control and the amount of money they are willing to spend for such activities. As will be shown later, present expenditures fall considerably short of the needs in every forest region and, largely, in proportion to the excess in the ratio of present burned-over acreage to the desired objective in allowable annual burn.

In the national forests, where the fire-control problem has been progressively met with increased appropriations for intensified protection effort, present expenditures for the whole national-forest area more nearly approach ultimate needs. But even here, as indicated in table 6, about 30 million of the 95 million acres requiring protection are still burned over to a considerably greater degree than the objective set up, and in these areas protection costs must be materially increased.

The present per-acre costs for all national forests given in table 9 are very much higher than per-acre costs on State and private land, but they include every direct and indirect item of expenditure. The lowest costs per acre are found in the South Rocky Mountain and New England regions and the highest in the Central and the South. The high costs in the latter regions are in part due to the fact that the units protected are comparatively small and require protection against threatening fires from outside areas which are frequently costly to handle. These costs will be reduced as additional territory is added to round out these properties. The higher costs in the Pacific Coast and North Rocky Mountain regions reflect the difficulties of fire control in highly inflammable forests on adverse terrain.

TABLE 9.—*Average annual costs of protection on national-forest areas and cost per acre by regions (average 1926–30)*

Region	Total cost	Cost per acre
	Dollars	*Cents*
New England	21, 476	4. 05
Middle Atlantic	28, 525	7. 73
Lake	95, 472	5. 56
Central	68, 156	10. 26
South	317, 756	9. 30
Pacific Coast	2, 569, 394	7. 50
North Rocky Mountain	1, 917, 266	6. 79
South Rocky Mountain	419, 553	1. 62
Total	5, 437, 598	5. 72

In table 10 the regional costs for the protection of national-forest areas are segregated by the major elements. It will be noted that the annual carrying charges and maintenance of improvement roads and trails forms a large item of the fire-control costs in the national forests, because vast inaccessible areas have to be broken up with a transportation system for the movement of men and supplies. In contrast to this, much of the territory outside of the national forests is in the more settled and developed sections, where existing roads already furnish the basic transportation system. Besides, new roads in private and State protective units, even where their use for protection is important, are, as a rule, built chiefly for such uses as intercommunity travel and utilization and thus are not ordinarily included in fire-control costs.

TABLE 10.—*Annual cost of fire control on national forests, by regions (average 1926–30)*

Region	Prevention and presuppression	Improvements—roads, trails, and other [1]	Fire suppression	Total
New England	$8, 411	$795	$12, 270	$21, 476
Middle Atlantic	7, 640	3, 026	17, 859	28, 525
Lake	39, 400	28, 222	27, 850	95, 472
Central	30, 640	14, 077	23, 439	68, 156
Southeast	138, 069	54, 845	124, 842	317, 756
Pacific Coast	863, 981	853, 049	852, 364	2, 569, 394
North Rocky Mountain	577, 468	759, 548	580, 250	1, 917, 266
South Rocky Mountain	138, 539	67, 278	213, 736	419, 553
Total	1, 804, 148	1, 780, 840	1, 852, 610	5, 437, 598

[1] Annual carrying charges.

Recognizing that per-acre costs will vary with the difficulty of the fire-control job and the skill with which the work is done, and that these differ between regions, the inescapable conclusion must be drawn that in the main, where present burned-over areas materially exceed the objective, the present scale of expenditures is inadequate.

ADDITIONAL EXPENDITURES NEEDED

ON THE NATIONAL FORESTS

During the past decade, painstaking studies of physical factors and critical investigations of organization and methods have been made for the national forests to determine both the needs and costs of an adequate fire-control system. There is now in progress an additional series of transportation, detection, and organization studies which seeks to supply in detail what ultimate expenditures may be required for each national forest to meet its objective in fire control. This material as far as it has been available has been used as a guide in arriving at the proposed new schedule of costs. Additional expenditures have been considered only for those national forests where the objective in fire control has not been met or where additional capital outlay promises to result in a net reduction either in costs of fire suppression or in damage to forest values. The great bulk of the proposed increased expenditures as shown in table 11 is almost wholly for the 31.6 percent of the national-forest area classed as critical and now suffering from severe losses.

In examining the figures in table 11, it will be noted that increased expenditures are not contemplated in two regions, are less than 1 cent an acre in 2 others, between 1 and 1.5 cents in 3, and approximately 2 cents in 1. Of the increases proposed at least 74 percent is for the cost of additional roads and trails and includes capital investment and maintenance. In several instances the additional mileage is needed because of the expanding area of the national forest as the units are built up by additional land purchases, and, in the case of the South Rocky Mountain region, to reduce fire-suppression costs. Since the present net area was used to arrive at the annual charge per acre for carrying the investment in transportation, the figure will become less and less as the purchase program is completed. It will be noted that in five regions the additional expenditure for roads and trails will make possible reductions in present costs to the point where the total additional is less than the transportation increment.

TABLE 11.—*Present and proposed annual costs per acre for adequate fire control on the national forests*

Region	Present costs	Proposed costs	Total additional	Proposed for roads and trails [1]
	Cents	*Cents*	*Cents*	*Cents*
New England	4.05	4.05	----------	----------
Middle Atlantic	7.73	8.61	[2] 0.88	1.1
Lake	5.56	7.035	1.475	1.647
Central	10.26	11.378	1.118	1.52
South	9.30	10.33	1.03	1.6
Pacific Coast	7.50	9.823	2.323	1.564
North Rocky Mountain	6.79	7.59	.8	.6
South Rocky Mountain	1.62	1.56	(3)	.025
Average (weighted)	5.72	6.853	1.150	.851

[1] Capital investment and maintenance.

[2] Additional expenditure for better transportation will make possible a reduction of present cost in other particulars, resulting in a "total additional" cost actually less than that proposed for roads and trails.

[3] Slight additional expense for roads and trails would result in a saving of 0.06 cents per acre.

ON STATE, PRIVATE, AND OTHER AREAS OUTSIDE NATIONAL FORESTS

The ultimate costs of fire control for areas outside of the national forests, while not as readily ascertainable as those within, are based on careful estimates made in 1930 by the Forest Service cooperating with the States. The estimates have subsequently been checked against comparable costs on national forests in the same regions with due allowance for differences in accessibility and fire danger. These comparisons indicate that, in order to attain the fire-control objective set up in this discussion on the present area of State and privately owned forest land within the next 10 or 15 years, an annual expenditure of about $20,000,000 would be required, or the per-acre costs shown in table 12.

TABLE 12.—*Estimated present and proposed costs per acre of fire control on areas in State, private, and other ownership outside national forests*

Region	Present costs [1]	Ultimate costs	Total additional
	Cents per acre	*Cents per acre*	*Cents per acre*
New England	1.94	2.86	0.92
Middle Atlantic	2.77	3.35	.58
Lake	2.01	4.24	2.23
Central	.40	2.55	2.15
South	.43	5.43	5.00
Pacific Coast	3.28	6.43	3.15
North Rocky Mountain	5.90	8.39	2.49
South Rocky Mountain	[2].89	1.39	[3].50

[1] Present costs were calculated by charging the total expenditures against the total area needing protection although in the Central and South regions many million acres are entirely unprotected.
[2] Incomplete record of expenditure on private land in New Mexico.
[3] This figure subject to change as more complete records of current expenditures become available.

The estimate is not final and is subject to further revision as better data become available. In the course of time, as antifire sentiment increases, the cost of protection may be expected to decrease. On the other hand, the areas of forest and potential forest land as estimated in 1930 will undoubtedly have to be increased in future calculations because of additions from farm-land abandonment. It should be noted that these costs, in contrast to those for national forests, include only small present or proposed expenditures for roads or trails. In the main, such items will be financed, as in the past, out of highway and road appropriations as the need for additional community and State roads arises; whereas, on the national forests the cost of protection for roads is specifically provided for by Congress.

For the South region it has been extremely difficult to estimate the cost of adequate protection because of lack of information on the huge area now entirely unprotected. The $11,000,000 estimated for this region therefore must necessarily be regarded only as a reasonable approximation of ultimate cost if the total acreage given in table 4 were to be adequately protected. The task is, however, so great, and the probability of protection being given to the entire area is so uncertain, that if $6,000,000 were to be set up as the goal, it would more nearly represent the possibilities of attainment in the next 15 to 20 years.

The data in table 12 indicate needed increases in every region varying from 5.8 mills per acre in the Middle Atlantic region to 5 cents in the South. Relative increases are even more striking. In the South, where it has already been shown that the burned-over area is 13.8 times the ultimate objective, annual expenditures would have to be increased at least twelvefold if the total acreage were to be put under adequate control. In the Pacific Coast region, where the burn is five times the objective, double the present expenditures will be required.

In contrast with the estimate of $20,000,000 required for adequate protection of areas outside of the national forests, total expenditures from all sources have averaged about $5,400,585 for the period 1927–30, and reached $7,220,871 in 1931 (table 13). This wide spread between actual expenditures and needs is significantly reflected by the conditions in the South, where current expenditures are slightly under $944,000 a year and the requirements of the job as indicated in this study are more than $11,000,000; and in the Pacific Coast region and the Lake region where 1931 expenditures were over half a million less than the ultimate required amount.

TABLE 13.—*Total present and estimated ultimate annual cost of adequate fire control on areas outside national forests*

Region	Present expenditure [1]	Ultimate cost
	Dollars	*Dollars*
New England	511,331	792,000
Middle Atlantic	[2] 1,165,859	955,000
Lake	1,668,788	2,219,000
Central	250,278	1,337,000
South	943,955	[3] 11,018,000
Pacific Coast	2,059,637	2,684,000
North Rocky Mountain	603,863	793,000
South Rocky Mountain	17,160	30,500
Total	7,220,871	19,828,500

[1] The costs which are for the calendar year 1931 vary considerably from average expenditures over the 5-year period 1926–30, upon which the per-acre costs in table 12 are figured. Nevertheless they serve to illustrate in several of the regions that "ultimate cost", or the desired annual expenditure may often be little more than the unavoidable expenditure in any one year, resulting from large suppression expenditures.

[2] The increase in present expenditure over ultimate cost for the Middle Atlantic region is explained by the occurrence of an unusually bad fire season in 1931, calling for greater than average suppression costs. Reference to table 12 will make it clear that ultimate costs are reckoned as at least one fifth higher per acre than average present costs.

[3] Based on the supposition that the total areas given in table 4 is to be given protection.

Expenditures during the fiscal year 1932 in areas outside the national forests were shared by the private owners of land, the Federal Government (through the Clarke-McNary Act), and the States in approximately the following proportions: by private owners, 18 percent; by the Federal Government, 26 percent; and the remainder, or 56 percent, by the States.

THE IMMEDIATE FINANCIAL PROGRAM

OUTSIDE NATIONAL FORESTS

The basic steps in a fire-control program have been discussed. If forests and watersheds are to be made reasonably safe against further ravages of uncontrolled fires, and if the required objectives in fire control are to be reached within reasonable time, honest recognition must be given to the fact that more money is needed for the job.

Total and present expenditures for areas outside the national forests, as given in table 13, indicate the need of greatly increased fire control expenditures in order to bring fire losses down to an acceptable figure. All participating agencies, Federal, State, and private, should contribute more than at present and the total should be increased as rapidly as the funds can be used efficiently. The Federal appropriation for the fiscal year 1933 is only $1,611,580 although the Clarke-McNary Act authorizes an annual appropriation of $2,500,000 for this purpose. Further discussion of principles and policies which should govern Federal participation in this work will be found in the section of this report entitled "Federal Aid to States and Private Owners."

ON NATIONAL FORESTS

The increases needed per acre on the national forests, as given in table 11, represent an objective to be attained not later than the end of the next 10-year period. To this end the following program is offered:

1. Roads and trails—annual program for 10-year period (this includes maintenance)	$3, 700, 000
2. Other improvements such as telephone lines, lookout structures, etc., annual program for 5 years, including maintenance and replacement	780, 000
3. Increased man power—starting with an addition of $80,000 to present appropriation during the fiscal year 1934 and increasing to $625,000 at the end of the 8-year period when the road and trail program approaches completion and the construction crews will not be available for fire control work	80, 000–625, 000

These items cover the investment that should be made for the required transportation system, the physical plant, the essential equipment, and additional man power. In comparing the proposed expenditures for roads, trails, and other improvements with the costs per acre given in table 11 it is necessary to remember that this class of expenditures represents a capital investment from which the annual cost is obtained by amortization. For example, it is estimated that protection roads will last, on the average, 40 years, and the construction cost is therefore charged off over a 40-year period.

The need for increased man power will become acute as the road and trail and improvement jobs near completion and this source of labor is moved out of the country, and this explains the considerable annual increases in present funds appropriated for fire control up to a total increase of $625,000 as the road program approaches completion. To balance this expenditure, however, an annual saving of some $600,000 in fire-fighting costs may be expected as the system reaches completion.

IN NATIONAL PARKS AND NATIONAL MONUMENTS

According to information supplied for this report by the National Park Service there are 8,426,046 acres in national parks and monuments, including parks and monuments in Alaska and Hawaii. Much of this area is susceptible to damage from forest fires. The average annual expenditure for fire suppression for the 6 fiscal years 1927 to 1932, inclusive, was $95,324.85, and the average area burned annually during the last 5 calendar years, 1927–31, was 19,072 acres.

The Park Service estimates that the following additional capital investment in fire protection improvements is needed, the investment to be made over a 5-year period:

Lookout houses and towers	$48, 600
Telephone lines	42, 327
Tool kiosks and tool houses	18, 550
Guard cabins and barns	18, 925
Roads	65, 000
Trails	284, 772
Water development	3, 950
Grand total for 5-year period	482, 124

This would mean an annual expenditure of $96,425 for this period.

The Park Service estimates that a total of $63,214 is needed annually for fire prevention services and maintenance.

This amount added to the annual expenditure of the 5-year protection improvement program gives a total of $159,639 which is the average annual fire protection expenditure estimated as necessary by the Park Service.

ON INDIAN FOREST LANDS

It has been estimated that approximately 9 million acres of the Indian lands is actually forested out of a total of 7½ million acres, and 8 million acres, respectively, of commercial and noncommercial forest land. The Director of Forestry in the Office of Indian Affairs has supplied for this report the following data on forest fires on Indian lands.

The average annual expenditure for fire control during the 6 fiscal years 1927–1932, inclusive, was $94,528. During the same period the average area burned annually was 85,563 acres. The allowable burn is 40,000 acres annually and the estimated annual expenditure needed to bring the burned acreage down to this figure is $450,000 including fire prevention, fire suppression, roads, trails, telephone lines, lookouts, and other fire protection improvements. This large increase is largely for capital investments.

PUBLIC DOMAIN

At the request of the Commission appointed by President Hoover to make a study and report with recommendations for the solution of the public-domain problem, the Forest Service in 1930 made an estimate of the cost of fire protection for this land. The following acreage and costs are taken from the Forest Service report.

The total area of the public domain is given as 173,318,246 acres, of which 32,244,263 acres is considered as needing some degree of fire protection. On some of this land, as for example the piñon and juniper foothills in the West, the fire danger in many places is very low. The timber values and watershed values are also comparatively low in some cases. The cost estimates consequently are low compared with actual costs on high-value and high-danger forest lands.

It is estimated that the cost of adequate protection of this 32,244,263 acres will amount to $723,598. This estimate is based on national-forest standards of protection and assumes that wherever the public domain forms logical parts of the national-forest system these areas will be added to the existing national forests and administered as a part of them. This of course would facilitate administration and reduce the cost of protection. Separate administration undoubtedly would increase the total cost above the estimate given. Further and more detailed discussion of the public domain will be found in the section of this report entitled "Public Domain and Other Federal Forest Land."

PROTECTION AGAINST FOREST INSECTS

By the Division Forest Insects, Bureau of Entomology

The importance of insect activities in the growth and development of the forest from the time the trees are planted until they are harvested, and even to the products after they are put to use, has already been pointed out. To briefly recapitulate, insects cause enormous losses in mature stands of timber which are being held in reserve for future needs. They lower the yields and affect the rate of growth of developing stands. They frequently change the composition of the forest to such an extent that complete reshaping of the plan of management is necessary. They create serious fire hazards and take a varying toll from crude and finished forest products. On these grounds the consideration of insects in the forest is primarily a matter of protection to be secured through the early detection and suppression or the prevention of insect outbreaks, but also of equal if not greater importance is the matter of the necessary research for developing this protection. The ways and means of obtaining more adequate results in protection from forest pests is discussed in some detail as follows:

1. The prompt control of forest insect outbreaks when such control is economically sound in the broadest sense must be provided.

Just when, where, and how to do control, and at the same time secure maximum protection consistent with the economic or aesthetic values at stake, is the key to the entire problem.

The policy of letting nature work things out in here own way has some merit. Such a course of action at least involves a minimum of effort and cost. This policy of "letting nature take its course" is in fact the one that has been followed too often, with results that are all too evident. If we accept this as a course of action, we must also accept the probability of slow or sudden depletion of the older forests, which as they stand today are ripe and ready for the beetles. If we are willing to do this and wait for nature to replace these losses by the slow process of growing a new crop of trees, then the matter of taking any further steps to expand our present efforts can be dropped from consideration.

On the other hand if we were to launch out upon the policy of combating all threatening barkbeetle infestations everywhere, the cost would be enormous. One million dollars would be a very conservative estimate of what could be spent to advantage in California alone durthe present winter and spring for the very good purpose of killing beetles that are destroying timber of high value; and in the lodgepole pine forest around Yellowstone National Park over $2,000,000 could be spent this spring. Such expenditures should of right be carefully questioned from all angles, and the plans for any large control projects governed both by economic considerations and the entomological factors which involve the prospects for successful results. Intelligent planning should therefore underlie the expenditure of both public and private funds for control jobs of this character.

There are two distinct classes of timberlands needing protection from insect pests—those where a present or future commercial value is the chief consideration and those where the esthetic values are predominant. A third class, the so-called watershed or protection forest, need not be given consideration at this time except when the infestation threatens other timber of greater value. The commercially valuable timber includes that on lands of the national forests, Indian reservations, public domain and private lands. The timber needing protection because of its esthetic values lies in the national parks, State parks, and on small areas of the national forests devoted to recreational use.

A reasonable policy for forest insect protection has already been adopted by the National Park Service (A Forestry Policy for the National Parks, approved May 6, 1931). This adequately meets present needs and as it well illustrates both entomological and administrative considerations, it is quoted herewith.

> *Insect control policy.*—It will be the policy to secure and maintain, so far as practicable, full protection from insect epidemics in areas of the following character within the national parks and monuments.
>
> (1) Areas of intensive use, such as camp grounds.
>
> (2) Areas of important scenic or esthetic attraction (unless the partial loss of the tree species attacked within a mixed stand will not materially affect the general appearance of the stand and its scenic or esthetic value, nor materially add to the fire hazard).
>
> (3) Areas of prospective intensive use within the next 10-year period.
>
> (4) Areas within the national park threatening protected areas within or outside the national park.
>
> (5) Areas of unusual fire hazard.
>
> (6) Areas set aside for study and research (unless natural agencies are to be left undisturbed).
>
> Complete protection in the sense here used would call for removal of light endemic infestation in areas of intensive use.
>
> With such insects as the mountain pine beetle in lodgepole pine and the Black Hills beetle in ponderosa pine, there can be no question but that every outbreak should be immediately controlled before it develops into a widespread epidemic costing often thousands of dollars.
>
> Quite a different example is presented in case of the western pine beetle in Oregon and California. This beetle takes annually a small percentage of the stand and at intervals of some years a considerably larger percentage. The main objective in controlling the depredations of this beetle would be to prevent the peaks of this type of infestation developing and thus prolong the life of the existing stand over a longer rotation of gradual replacement; in other words, the objective would be to carry on a certain amount of maintenance control from year to year in an effort to keep the losses at the lowest possible status all the time.
>
> With defoliating insects, it is possible to readily control them where the trees are accessible to high-powered pumping equipment such as along main highways. Within a few years it may be practical to use airplanes for dusting some of these infestations.
>
> Under the above policy, remote areas of no special scenic value and not of high fire hazard, little used or seen by the public and not planned for intensive use within a reasonable period of years, may be omitted from insect control plans if they will not endanger control in adjacent areas, unless there are other special factors which make their protection from insects important.

In the national forests or other public lands where timber values are the main consideration, these values must be weighted against the probable future time of logging, the possibility of salvaging the insect-killed timber, the species of insect causing the destruction and the degree of virulence of the infestation. These considerations apply equally to private lands and it can be said in general private owners have more often taken the initiative in applying control than have the Federal agencies. It is obvious that with the intermingling of various classes of Federal and private timber each requiring different degrees of protection and the entomological technalities involved closest cooperation is required for the successful conduct of control work. The means developed to meet these complex needs are discussed under "The Progress in Forest Entomology".

For the fiscal year 1933 there is available for insect control in Federal services as follows: Forest Service, $100,000; National Park Service, $50,000; and Bureau of Indian Affairs, $20,000. These funds are totally inadequate as evidenced by the call for extra money through various deficiency bills. It is conservatively estimated that in order to meet present needs for protection from forest insects $400,000 is needed annually by these agencies administering Federal lands. On the basis of this same degree of protection $200,000 should take care of insect outbreaks on private lands, and $15,000 on State-owned lands. This amount will only be adequate for a few years to come. As timber now economically inaccessible becomes more valuable, and as the recreational areas on the national parks are expanded, more and more of these insect outbreaks must be controlled.

2. A well-organized system of detection is necessary to—

(*a*) Avoid the introduction of injurious foreign insects;

(*b*) To detect outbreaks of native insects in the early stages in order that control work may be initiated when it is most effective and least expensive.

The need for taking every reasonable measure for the interception of foreign pests before they become established in the country is fully appreciated and the dire consequences that can follow such introduction are well illustrated by the destruction caused by the gipsy, browntail, and satin moths and the European pine shoot moth.

Early detection of insect outbreaks is obviously a prerequisite to control. The failure of certain control projects has been the result of tardiness in recognizing an active infestation or in incomplete information as to its virulence and extent. It is obvious that a well-executed system of detection, coupled with prompt action in control, will prevent the development of many barkbeetle outbreaks such as we are now witnessing and powerless to stem. Such a program is economical not alone because of the timber saved, but as well in the actual outlay of money for control. Throughout the western States cooperative detection systems have been set up between the Federal land administering agencies, States, private owners and the Bureau of Entomology. These so-called regional surveys are in various stages of perfection, depending on the values at stake, the degree of insect hazard and the funds available. These projects should be extended and carried to the point where the forest areas can be zoned according to their susceptibility to insect infestations, and each susceptible area rated according to values, whether for potential lumber or for park and watershed cover. This will give a basis for decision as to the areas that the owner or administrator should protect and the areas that will be deeded over to the insects when the advance guards of the epidemic appear and present claim to the timber.

3. An adequate program of forest research.

Research is absolutely essential to the perfection of all phases of the practical application of forest entomology, whether it be direct control, prevention, or the use of beneficial insects. The extent to which this application depends on the peculiar habits of each species of insect has already been pointed out in the section entitled "Progress in Forest Entomology". Through research direct control methods against tree-killing barkbeetles in the West have been gradually cheapened and made more effective. With other insects it has been found feasible to prevent their destructive activities by methods applied in the management of the stand. Research is also necessary to use beneficial insects to the best advantage. It has been demonstrated to be quite feasible to import beneficial insects from one country or section of a country to another, establish them, and obtain effective control through their activities.

A great deal of experimental work is needed to perfect methods of combating defoliating insects. At the present time the use of poison dust distributed from airplanes seems to be the most practical means of control but too little has been done in this line to speak with any authority. Satisfactory poisons have not been developed nor has the mechanical application over forested areas been perfected. Here again the spending of large sums of money on work that is not carefully planned and is lacking in definite objectives is open to question. Research must often proceed slowly, following the promising leads as they are uncovered and carefully checking results before they are given out. This type of work, therefore, offers the greatest possibilities for the discovery of new methods and short cuts to effective handling of the problem, and therefore deserves high priority in the future development of a balanced program.

The first appropriation specifically designated for research in forest entomology was made in 1902 to the Bureau of Entomology. It was $5,800. Since then gradual increases have been made to a maximum of $139,000 for the fiscal year 1931. (This does not include $104,530 expended on the gipsy moth project, which was combined with forest insect investigations about this time.) In that part of the appropriation applied strictly to forest insects some 50 percent is expended for extending service in control work to other Federal agencies and on intermingled private lands.

The needs for the satisfactory expansion of research in this field have been authorized by Congress in section 4 of the McSweeney-McNary Act of May 22, 1928 (45 Stat., 699). This provides for a gradual increase to a total of $250,000 which would take care of the most imperative studies for which some 5 years to come.

4. An educational program to make more effective objectives 1 and 2.

Although the Bureau of Entomology assumes responsibility for the decision as to when control is necessary and for the methods to be applied, it is obvious that the more thoroughly the local administrative officers understand these matters the better will be the results obtained. For this reason, the Bureau of Entomology has been devoting some effort to educational work among the field men of various agencies administering Federal lands. This field personnel in close contact with local conditions should be able to recognize insect outbreaks in the incipient stage and report to those competent to judge the seriousness of the situation. Consequently entomologists have been dispatched to many of the district ranger camps maintained by the Forest Service and to the instruction meetings of the National Park Service. Leaflets of instructions and reports have been prepared and disseminated through the administrative personnel, and many local contacts have been made with the field men of other agencies. There is need of much greater expansion of this work, and there should be available men specially designated to handle and enlarge this educational and extension work.

PROTECTION AGAINST FOREST DISEASES

By Carl Hartley, J. S. Boyce, and others[1] in the Bureau of Plant Industry

CONTENTS

	Page
Investigation	1419
Organized control	1423
Service force for control application	1424

INVESTIGATION

NECESSITY

The first, and for a long time one of the principal, activities in any program that can be laid down now with reference to forest diseases is research. There are 180 native timber species in the country of importance for production of wood, and still others that are of more or less importance from the standpoint of aesthetics or watershed protection, in addition to a few introduced species which demand attention. To distinguish the different diseases which attack any one of these tree species, determine their causes, find out what conditions or forest management practices affect their spread and what strains or varieties are resistant to them, requires many years and the collaboration of mycologists, anatomists, physiologists, etc. To cover adequately even the 25 most important tree species would take not less than half a century with a force of investigators as small as that now active in the field of forest pathology. Superficial studies reveal ways in which a few diseases can be controlled or avoided, but to get economically practicable methods of cutting down the losses from most diseases it is necessary to know the fundamental facts about them.

SUBJECTS TO BE EMPHASIZED

The State of New York is now beginning an extensive 20-year program of acquisition and reforestation, by planting of lands suitable only for growing trees, involving the expenditure of about $20,000,000. To a lesser extent, forest planting in the Lake States may be increased in the immediate future and planting promises to become more extensive in some of the other forest regions. This planting will be almost exclusively softwoods and largely in pure stands. Nursery capacity for providing stock will have to be increased. Trees grown in nurseries and plantations have proven more subject to disease than those naturally regenerated, so that in these nurseries and plantations we can expect not only an increase in the diseases at present troublesome in the wild stands, but a number of new or little-known diseases which may cause serious damage. These will require investigation and control. Furthermore, selection of seed from healthy mother trees from a locality with climatic conditions similar to that of the place at which the trees are to be set out and selection of planting sites adapted to the species are essential for the development of satisfactory plantations. Experience shows that in large-scale planting operations this is not now done consistently, with the result that trees from an improper source of seed or on unfavorable sites suffer seriously from avoidable disease. All this demands an increase in the study of nursery and plantation diseases, and particularly of root diseases and their relation to soil conditions, far beyond anything that has so far been done.

---

[1] S. B. Detwiler and W. W. Wagener, assisting.

Directly bearing on nurseries and plantations is an investigation of the mycorrhizal relations of forest trees already begun in a small way. Experience in other countries has indicated that the failure of some plantations is directly connected with the failure of tree roots to develop mycorrhiza. On the other hand, there is reason to suppose that some kinds of mycorrhiza or any mycorrhiza under some conditions are harmful. There is also need to study the correlation of soil factors with disease on planting sites.

Individual trees of the same species grown under the same conditions vary greatly in their resistance to disease. The basis neither of their resistance nor their immunity is known, nor to what extent this character is transmitted through seed to their progeny. This is probably the most time-consuming problem in forest pathology, yet it is of fundamental importance in reforestation because of its bearing on the choice of seed for growing trees. It is already too late for this line of attack to be of any value to reforestation work for the next decade, but under a long-time program it should begin immediately. The marked success attained with agricultural crops is all that is needed to illustrate the far-reaching results to be expected.

In the West the application of blister-rust control to 5-needle pine stands and reduction of the damage to softwood stands caused by dwarf mistletoes are outstanding problems.

Decay in living trees in the future can be largely avoided by cutting stands before they reach the age at which decay becomes extensive. Investigations have determined this age for a few species, but it must be obtained for all defective species and for each of them on different sites before management can be placed on a sound basis. Furthermore, there still remain extensive stands of badly decayed timber in which information on the rate of decay and the outward evidences of decay are essential for intelligent utilization and salvage. Better knowledge of the relation of decay to wounds is a primary need in much of the eastern hardwood region. Investigations on the control of decay must be carried on for years to come.

The proper disposal of slash after logging is important to the development of the new forest. Present slash-disposal methods in managed forests are usually expensive. Investigations by pathologists on the relation of decay to various methods of slash disposal have already resulted in modifications of method in certain regions, greatly reducing expense; further extension of these studies should be made to all regions where slash disposal is a problem.

The use of forests for recreation is increasing greatly. While study of forest diseases in general will bring out results of value for recreational forests, yet control measures must differ markedly from those applied to forests of which the primary purpose is timber production. New factors will present themselves as investigations proceed; only by the application of control measures based on fundamentally sound information will these huge recreational forest lands adequately and permanently serve the purpose for which they are so valuable. Consequently specialized study of diseases in recreational forests which has just begun will need to be continued for an indefinite period.

The most serious threat to our forests is in new parasites, introduced from foreign countries. In spite of quarantine regulations, we must at all times be prepared for the introduction of diseases as destructive as chestnut blight or white pine blister rust. One of the best safeguards against sudden and disastrous epidemics from such a cause is knowledge of our native diseases, and there should be a sufficient number of forest pathologists in the different parts of the country and in touch with the forestry workers so that a newcomer among the diseases will be recognized as such soon after it enters the country and while there is still time to eradicate it or at least to delay its spread. The pathological organization should furthermore be sufficiently large to be able to put a number of trained men on investigation of an introduced disease at short notice without having to take the workers from other projects which depend for success on continuity of effort. This means the maintenance of a larger research organization than would be barely necessary for study of native diseases, just as the country maintains a larger army during peace times than is needed, that it may form the nucleus of an expanded organization in time of war. At times it is essential to make investigations of threatening diseases in the country of origin, to help in devising efficient quarantine regulations for their exclusion, or to furnish information or assistance in eradication efforts against diseases that have already been imported.

Pathological investigation can make the most immediate contribution toward maintenance of timber supplies through a study of the fungi that attack forest products. By the best estimates available, the volume of our annual saw timber cut which is used for replacing wood that has decayed in storage or use is equal to about one half of the annual growth. Our unfavorable timber supply balance sheet can be most quickly helped by preventing some of this waste. Fairly satisfactory but expensive methods of preventing decay by preservatives are being applied extensively in the rougher types of use. Cheaper methods and methods that can be applied to wood in house construction, that will be free from danger to the occupants and otherwise less objectionable than present preservative processes, need to be developed. Timber preservation has already been considered more specifically in the section entitled "Enlarging the Consumption of Forest Products."

The chemical methods for prevention of sap stain have been carried far enough to show that this defect, which aggravates the difficulties of both wood producer and wood consumer and increases the forest drain, can be almost entirely prevented by inexpensive procedures. Preliminary results of the studies on this subject have already been carried into large-scale practice in some localities. Further study will be needed to bring the treatments to a point of consistent effectiveness and adapt them to different localities, timber species, and types of utilization.

One of the less obvious but no less important research projects is to simplify the precautions in methods of handling and use of untreated wood that are recommended to protect it from fungous attack.

There is a good deal of information as to how to dry wood quickly, how to keep it dry, and how to choose the kinds of wood that will be most resistant under conditions of decay hazard. Unfortunately, the knowledge of the relation of these practices to fungous damage is mainly empirical. There is need for much additional fundamental study, for example on the fungi that cause decay, on methods of distinguishing different kinds of decay, on the durability of wood cut from different species or at different seasons, and on the limit of moisture content to which wood must be dried to render it safe from the most active decay fungi.

Following or parallel with such fundamental research, field studies should be made on the relation of decay to methods of cutting, seasoning, storing, and using the wood, including sanitation in lumber yards, and particularly on the so-called dry rot of buildings which often causes disastrous losses to individual house owners and which does not always follow the currently accepted views as to which types of design are safe and which favor decay. The relation between decay and termite injury in wooden structures is also in need of study.

AGENCIES

It is desirable that Federal, State, and private agencies take part in investigations of the types described above.

There should be stationed at each of the regional forest experiment stations of the Federal Government at least two pathologists, to be supplied and technically supervised by the Bureau of Plant Industry; isolated workers in specialized fields of this sort are relatively inefficient in both quality and quantity of output. Adequate forces at stations in such important timber sections as the Gulf States and the Pacific Northwest would consist of not less than 5 or 6 men with pathological training, and at other stations there should preferably be 3 or 4. Investigative work of the types now under way at Washington should be continued at Washington because of the need in these particular investigations for the library and herbarium facilities and contact with plant-introduction and quarantine organizations that can be gotten nowhere else. Studies of the pathology of forest products, the fundamental aspects of which are best carried on by pathologists of the Bureau of Plant Industry stationed at the Forest Products Laboratory at Madison, need to be enlarged both at Madison and at the Southern Forest Experiment Station and to be begun at one of the forest experiment stations of the Pacific coast, and probably later at the Northeastern Forest Experiment Station. This would mean placing pathologists at eight stations not now served, and enlargement of the pathological staff at the three stations where such work is now in progress.

The greatest field for expansion in research in forest pathology seems to be in the States. The small amount of State effort along this line has been described earlier. While problems of equal importance to a number of different States can be most logically studied by the Federal regional experiment stations, it would seem proper that the States should be more active in solving problems of concern to them and especially those which are not important to other States. In many cases the best results could be obtained by cooperation between Federal and State agencies charged with such investigations.

Private lumbering or wood-using interests should also be expected to conduct or contribute to the cost of conducting research, particularly in the pathology of forest products, to a greater extent than at present. Organizations erected primarily for commercial profit will rarely be justified in any but the most local and superficial investigation of the diseases affecting forests; they should, however, be encouraged to employ investigators or contribute funds for the enlargement of research by existing agencies, whenever they encounter problems of economic importance in the field of wood utilization, as in pulp and paper or wood preservation work on which they desire particularly early or complete information. Experience has shown that investigations supported by industry can rarely be expected to have the continuity or disinterested quality needed for fundamental research and that outside of governmental agencies only endowed universities and research institutes can be expected to aid materially in the more fundamental studies. There is some reason to believe that the State and Federal Governments would do well to devote their investigative energies to a greater extent than at present to the more fundamental phases and to require industry to finance to a greater extent investigations of immediate economic benefit. It will be practicable to apply such a policy only in cases in which the industry to be benefited is already organized on a reasonably large scale. The small sawmill operator, for example, like the small farmer, must continue to have most of his problems solved for him. Better-organized groups are ordinarily better able to utilize research results, and can usually be induced to support experimental work after preliminary Government investigations in their fields have educated them as to the benefits that can be derived. Much of the immediately applicable experimentation and nearly all of the fundamental studies on which immediate economic investigations must be based will therefore have to continue to be carried on by State or Federal agencies.

ORGANIZED CONTROL

A control or rather prevention process for which governmental organization must function is quarantine against diseases from overseas. The present regulations of the Federal Bureau of Plant Quarantine, allowing the introduction of tree propagating stock, other than seeds, only under supervision of the Bureau, should be continued. Particularly stringent regulations, such as those now applying to elms, should be made against the entry of other especially dangerous species as fast as studies made by pathologists at home and abroad make it possible to determine what species and kinds of material are most likely to carry infection.

The fact that most of the forest-tree diseases present on the Pacific slope in this country are quite different from those occurring in the East has caused some study to be given to the possible desirability of restricting the interchange of forest trees between the two regions. Protective measures of this kind, if adopted, could be undertaken only by the Federal Government. One of the developments which brings such a proposal to the fore just at this time is the accumulation of evidence of the destructiveness of the western dwarf mistletoes of pine which do not occur in the East. The feasibility of quarantine action to prevent their introduction into the Eastern States has been given some attention by a number of forest pathologists.

Eradication of recently introduced diseases that have eluded the quarantines must be done cooperatively by Federal and State agencies. A disease that endangers the forests of several States may be first introduced in a State that has relatively little forest, and which consequently has so little interest in the disease that it cannot be expected to finance eradication; but since Federal officers cannot legally enforce eradication, State authority, and therefore State cooperation, is needed. To eradicate a new disease completely it must be detected promptly and attacked immediately by experienced men. The only way in which this can be made possible is by maintaining not only the research workers previously mentioned but also more control workers on forest diseases than are absolutely needed in ordinary times. Such a force would improve the chances for locating promptly the new diseases that come in, and if maintained by the Federal Government would serve as a framework for quick development of any eradication force that may be needed for a specific disease in any part of the country. A skeleton control force kept up by the Bureau of Plant Industry as a measure of preparedness for eradication work could very profitably be used at times when no emergency threatens in scouting for new diseases or in such service work in disease control as is described under the following heading.

For introduced diseases so well established by the time they are detected that complete eradication is not practicable, an organized campaign will sometimes be necessary to delay the spread of the disease or to control its effects locally before it has time to do serious damage. This should include the prevention by Federal action of shipment of nursery stock or other infectious material from infected States to States still uninfected. In the case of such naturalized diseases for which investigation develops practicable methods of local control, there should also be developed at the earliest practicable moment a service force of the sort described in the following paragraphs.

SERVICE FORCE FOR CONTROL APPLICATION

For the local control of native diseases or established foreign diseases there is little warrant for active governmental participation. Such control work is a function of the individual landowner. There is furthermore at the present time relatively little place for extension activities of the usual type for disseminating information of forest-disease control. The methods of lectures, group demonstrations, and popular publications employed in the extension of information on diseases of crop plants are not adapted to getting forest-disease control practices into use. The details of practical application of control principles have not yet been worked out far enough to allow issuing rules of thumb that would be easily grasped and that would apply generally to the timber lands of a region or even of a single locality. Stands differ from each other in tree species, in age, in stand density, and in the diseases present, so that it is doubtful if group extension methods can ever be applied without a good deal of modification. In order to get the available knowledge in forest pathology into large-scale use with reasonable promptness, there is need for direct contact between the timber owner and a technically trained service man in State or Federal employ. Such contacts are particularly necessary if the farmer and small sawmill operator are to get the benefit of scientific developments. For highly infectious diseases, in which the uncared-for stand in one woodlot will spread disease to those that are cared for, it is impossible to secure the general and simultaneous cleaning up of disease that is necessary unless there is a service man to educate, stimulate and frequently locate the more backward owners. A service force to supplement the efforts of the investigators in promoting forest-disease control is believed to be an essential part of any well-rounded-out forestry program.

The development of most forest diseases, like the growth of the trees they attack, is inconspicuous, and the owner does not realize the size of the cumulative losses that they cost him unless they are demonstrated to him on his own land or that of a near neighbor. Very few owners realize the amount of decay that is allowed to enter their hardwoods when they fail to protect the timber from fire and logging scars. The improvement of the health and timber-producing capacity of the stand through properly conducted selective thinning or logging operations with low cost or with actual immediate profit is something that can be accomplished under ordinary market conditions in many stands, particularly in the more densely populated parts of the country, if the owner is shown the sanitary procedure best adapted and most economical for his own holdings.

The proposed employment of service men to secure application of research results has already been tried out on a large scale through a number of years in the white-pine blister rust control campaign and has fully justified its use. Without it there is very little likelihood that the northern white pine stands as a whole could have been saved; they certainly would not have been protected in time to have prevented very heavy losses from the disease. This service activity, supplied by the Division of Blister Rust Control of the Bureau of Plant Industry and cooperating State agencies, should be continued until the remainder of the pine land that warrants protection has been covered and until the control practice has been well enough established to be continued by local community effort.

Another specialized project in which a similar though smaller service force would be particularly helpful would be one on the diseases of forest nurseries and young plantations, on which as the reforestation movement increases there should be at least one pathology service man in the West, one in the Southeast, one in the Lake States, and another in the Northeast. Disease control for stands less than 15 years old in natural reproduction might also advantageously be serviced by the men assigned to nursery and plantation work, because of the similarity in disease type. With such an addition to their duties, two such men would probably be a minimum in each region.

For both nurseries and plantations their first and perhaps greatest service would be in helping the forester choose sites on which the species desired would be in the least likelihood of infection. Local advice needs to be given at each nursery, and for certain species also for each plantation, as to the needs and possibilities of removing from the neighborhood sources of rust and mistletoe infection. At nurseries already established, nurserymen need technical help in learning to distinguish between damping off and the very similar symptoms produced by high soil temperatures or by chemical or fertilizer injury; and between root rot and the similar symptoms produced by drought. They must often be stimulated and assisted to test comparatively the various alternative preventive measures in order to determine which is best and most economical on their local soils and for their local conditions.

For the general run of diseases of older stands, either planted or natural, service in control application should be developed, but only as fast as the knowledge obtained by the research workers becomes extensive enough to warrant the practical application. The region in which service men for general forest disease work could be installed with the most immediate return on the investment is the Douglas fir area in the Pacific Northwest. The scientific knowledge of decay in living Douglas fir timber has progressed far enough to serve as a basis for improvement in the processes of estimating and utilizing infected stands. With proper demonstration it should be possible to get into very general use methods of cruising that would greatly decrease the uncertainty element that decay introduces into lumbering operations, and methods of marking trees for felling and bucking that would decrease both the waste in money and waste in timber that occur in the utilization of infected stands.

In the Northeast where proximity to markets favors the utilization of small or defective material, much could be done by service men to stimulate the reduction of disease through the elimination in weeding, thinning, or logging operations of infectious material or of trees that would be liable to heavy infection before they could be utilized in the next cut. Thinning operations, particularly on farm woodlots where the work could be done by the owner during slack seasons so as to minimize the labor cost, could be made in many cases to earn their way immediately through use or sale of the material taken out; the improved growth and soundness of the trees remaining could thus be obtained without cost. Such sanitation incident to logging operations can also be accomplished at low cost, or at no cost at all in many cases where it simply involves a difference in choice of trees for cutting or where the defective material taken out can be utilized. For the small timberland owner whose woods holdings and operations are mainly incidental to general farming or other activities, service of this sort is particularly necessary if he is to avail himself of what is known about diseases; with the numerous tree species and diseases occurring in mixture in the timber of the Eastern States, a man must be something of a specialist in order to know how a particular piece of timber can best be handled for its future health as well as for immediate profit. The development of local market outlets for the material removed in sanitation cuttings is another form of aid by which the service man can facilitate the practice of disease control in woodlots.

In the field of fungous deterioration of forest products there is immediate opportunity for service activity to promote the intelligent adoption by the small sawmill operators of the eastern United States of the newly developed dipping treatments for preventing sap stain of lumber. One of these treatments has already been put into wide-spread use by the larger mills of the South, and should come into general use among them with only the servicing that can be done by the research men, the officers of the large-mill associations, and the manufacturers of the chemicals employed; but the full development of the use of the treatments by the small operators, who are the ones that are most in need of them, cannot be expected without a good deal of individual attention during the first few years.

The treatments must be adapted to small-mill use on the basis of numerous practical trials in regular small-mill operations; while the small operators would probably muddle through into ultimate successful use of the treatments, the process would be unreasonably slow and the cost of unsupervised practical trials of this sort is excessive. A good deal of lumber would inevitably be lost or damaged during the process, and without technical help in acquiring equipment there would be both waste of chemicals and very likely injury to workmen from poisonous action of certain of the chemicals used without proper precautions. The fact that the new treatments will not give complete protection unless the lumber is properly handled in other respects is a thing that is particularly difficult to impress on the small operator without some personal contact.

The sap-stain problem is a relatively simple one, which should be sufficiently disposed of by the combination of adequate research and service activity in a few years' time. Decay in forest products constitutes a much more complicated problem, and research in its prevention by methods other than the expensive and difficult impregnation with preservatives has not yet gone far enough to justify much active propaganda. It is believed, however, that the service personnel proposed for sap-stain work, which should preferably consist of at least 2 men in the Gulf and South Atlantic States, 1 in the Central and Lake States, 1 in the Northeast, and 1 in the West, could be gradually shifted into the more difficult decay problems as the sap-stain situation improves with increased attention to the Southwest. The problem of dry rot in buildings is a very serious one for builders and home owners in approximately the same sections as those in which sap stain is most serious, and the badly needed service work on this problem can be done more satisfactorily by men with a sap-stain service experience than by men without such experience in control of wood fungi.

The sap-stain problem affords a particularly good example of a case in which the technical service man could perform a double function, adapting the research man's results to fit the practical needs of different groups of users as well as stimulating the use of the adapted process. Similar practical experimentation has in fact been one of the important contributions of the blister-rust service agents, and pathology service men in general would undoubtedly make considerable additions to our supply of useful information along lines on which the regular research staff would have less opportunity.

The agency that should handle such service activity as has been proposed would have to be determined separately for the individual projects. For the seedling diseases, there are no States except perhaps New York and Pennsylvania that have a sufficient stake in young trees to be likely to install specialists for either research or service exclusively on them in the next few years. The four service men recommended for the different parts of the country in this project probably must be Federal. It might at first be desirable to attach them to the Division of Forest Pathology of the Bureau of Plant Industry in order to give them the full advantage of contact with the research on juvenile diseases done by that Division, but they would probably best be located ultimately with the Division of Blister Rust

Control of that Bureau, the scope of whose service work should be enlarged to include other diseases. The experience with the blister rust work, which was originally located in the first-named division, has shown that research and service work after the initial stages of development of basic control principles are better handled by separate personnel. As a general thing the best research men are not the best service men; while the handling of a service function by a research unit usually tends to disorganize and interfere with the indispensable continuity of the research work.

Service on the diseases of older stands had best be handled as the blister-rust work is now handled, headed up so far as Federal work is concerned by the Division of Blister Rust Control, the name of which should be changed in time to correspond with its wider function. Cooperation with State agencies in the principle timber-growing States on this general disease project should in general take much the same form as it does now with the blister-rust work alone. Federal control service on general forest diseases in any State should be conditional on contribution by the State, but part of the expense can properly be carried on Federal funds because of the interest of the consumers in all the States, particularly in the Northeast, in the maintenance of the timber supply. Entirely aside from the question of financial support, the participation of both State and Federal agencies in such service work is essential to the success of the project. Particularly when action is taken against an introduced disease, it is often necessary to require the cleaning up of infection centers for the protection of neighboring holdings, a function requiring the authority of a State officer. Federal participation is essential to make available to each State the experience in the others, a particularly important function during the formative period of the service activity, and to make part of the force mobile, allowing it to be moved from State to State and concentrated at any point where emergency need may arise. The above statements have more than theoretical basis, having been thoroughly justified by years of actual experience in the cooperative effort against the blister rust. The direction of the service work should pass increasingly into the hands of the State agencies, particularly in States which establish research work on forest diseases so as to improve the foundation of local knowledge required for the best service work. In States with less interest in the subject, it may prove impossible to have special service men in forest pathology alone, and the pathology service function may have to be carried by men who are paid partly for general forestry service. In any case it will often be desirable, in order to avoid duplication of travel, for the pathology service men to supply advice on control of forest insects or on general forest management as well as on pathology, and similarly for service on disease control to be given on occasion by entomologists or by foresters.

The service men proposed in connection with the control of the fungi that attack forest products are too few to devote any one of them to a single State, and State participation is therefore doubtful. Federal support of such work is justified by its bearing on the national timber supply. With normal business conditions it should be possible to secure part of its support from regional lumbermen's organizations, as has already been done for investigative work on sap stain.

HOW TO STOP FOREST DEVASTATION

By R. D. **Forbes**, Director Allegheny Forest Experiment Station, Forest Service

CONTENTS

Page
Introduction and summary 1429
Measures to be applied in western forests 1431
  Douglas fir type 1431
  Western larch—western white pine type 1435
  Sugar pine-ponderosa pine type 1439
  Ponderosa pine type 1441
  Other western types 1443
Measures to be applied in eastern forests 1444
  Longleaf-slash pine type 1444
  Shortleaf-loblolly pine-hardwoods type 1445
  Other eastern types 1446
Net cost of preventing devastation on private forest lands 1451

INTRODUCTION AND SUMMARY

An earlier section of this report, Current Forest Devastation and Deterioration, states that over 850,000 acres of forest land in the United States are yearly added by fire, logging, and other causes to at least 60 million acres already devastated. It describes the deterioration that has taken place on an overwhelming proportion of the remainder of the 10 million acres annually cut over in recent years. It makes clear, in short, that in spite of the increasingly effective efforts of the past 30 to 40 years to protect and renew the forest of this country, not only thousands but millions of acres that were productive in January of this year will be unproductive, or at best less productive, in December. Long-continued fire protection is making possible a gradual return of the forest to some areas earlier devastated—partly, at least, compensating for the current devastation—but the process is extremely slow.

Devastated land has been defined as land that, without artificial restocking, will not produce a commercially valuable crop of timber within a tree generation. The major cause of devastation is unquestionably fire. Fire in some parts of the United States is capable of reducing a green and productive forest to a charred waste, and consuming the very soil that might otherwise have nourished a new forest sprung from wind-blown or animal-transported seed. When fire runs through the wreckage of stumps, unutilized branches, discarded logs, broken and uprooted trees, that is the aftermath of commercial logging in the great majority of forests, it is almost certain to destroy the young tree growth already present, as well as such seed-bearing trees as may have been left standing by the loggers.

Although fire is the greatest single cause of forest devastation, other major causes are insects, disease, unregulated logging, and unregulated grazing. The timber-destroying bark-beetles of the West, and chestnut blight in the East, are familiar examples of the first two of these devastating agents. Protection against fire, insects, and disease has been discussed in the immediately preceding sections of this report, and it will be assumed in the present one that a high degree of such protection is being given to all forest lands.

Logging alone may devastate important areas of forest land, in addition to supplying the fuel for slash fires. (Logging, as the term is here used, includes not only the felling and removal of the timber, but also disposal of the slash; it covers removal of other products as well as logs.) Such modifications of logging as are necessary to prevent devastation are by no means always costly. On the contrary, under many circumstances they may result in a very substantial saving to the logger, and in the long run increase the return to the landowner. Painstaking studies conducted by the Forest Service and others in most of the important forest regions agree in showing that there are diameter limits below which trees cannot be cut and manufactured into lumber at a profit. Where such trees are left for seed, this measure to prevent devastation represents a saving of loss in operation rather than an added expense. Just as there may be "boarder" cows in a dairy herd, and "boarder" hens in a flock, that do not produce enough milk or eggs to pay for their keep, so there may be "boarder" logs in a sawmill. Such logs have cost more to cut and bring to the mill, and will cost more to saw into lumber, than can possibly be recovered from the sale of their products. Boarder logs should be left standing in the trees. Moreover, trees only a little above the diameter limit of present-day merchantability will often grow so rapidly in size and value, if left standing when their neighbors are cut, as to be worth much more to their owners on the stump than in the mill. "Economic selection" of trees to be cut, based on full knowledge of their present and probable future value, will leave most of the logged-off land in the United States well above the devastated class. Data steadily accumulate to show that the all-too-common practice of clear cutting not only devastates most forest land, but reduces profits and costs money. The fuller discussion of costs which concludes this section will substantiate these statements.

Devastation by logging is not permitted on the national forests, or on most other publicly owned land. The following description of the measures other than general fire protection necessary to keep forest land productive after logging is therefore confined to those forest regions where there is an appreciable amount of private forest land now being logged. In order to give a clear picture not only of the measures required but of the reasons for them, the more important forest types are treated separately. The great bulk of the information is quoted verbatim from the series of Department of Agriculture bulletins entitled "Timber Growing and Logging Practice" in each of a dozen forest regions, or from summaries of these bulletins brought up to date by further studies.

In addition to thoroughgoing fire protection given all forest land, the measures chiefly needed to prevent devastation of forest land are:

1. Preservation of young seedling growth already on the ground at the time of logging, or of such seed-bearing trees as are needed to reforest the land after logging. This requires care in felling and other steps in the logging to prevent injury or destruction of the advance growth and unmerchantable trees of valuable species; and in some cases deliberate reservation from cutting of merchantable seed trees, and their preservation in the subsequent logging. In

some stands, particularly of hardwoods, it may impose a delay in making final cuttings.

2. Slash disposal, or disposal of the debris of logging by some form of controlled burning, or other means, on all areas where it constitutes a serious threat of destructive fires. In few regions will it be necessary to destroy all slash; partial disposal, that is disposal throughout or surrounding areas of high risk, will be the rule. No disposal is necessary where utilization is very close. In regions of extreme fire danger special protection of logged-over land, until the slash hazard is reduced, will be either a subsitute for, or a supplement to slash disposal.

3. Prevention of overgrazing on reproducing areas. This requires consideration in comparatively few forest regions.

4. Miscellaneous measures, such as reservation of seed trees from turpentining in the South, and girdling or otherwise destroying old worthless trees which prevent valuable young growth from developing, in the hardwood forests of the East.

A table summarizes the necessary measures in each important forest type subject to devastation, and the net cost of stopping devastation of private forest lands is discussed.

MEASURES TO BE APPLIED IN WESTERN FORESTS

The main timber types of the West which are subject to devastation are the Douglas fir, the western larch-western white pine, the sugar pine-ponderosa pine, and the ponderosa pine proper, as shown in figure 2, in the section Forest Land the Basic Resource.

DOUGLAS FIR TYPE

For purposes of clearer discussion it is necessary to recognize two subdivisions of this type—the spruce-hemlock fog belt, and the Douglas fir proper.

THE SPRUCE-HEMLOCK FOG BELT

This subtype is essentially uneven-aged, often 2-storied, and consists of a variable mixture of the high value spruce and Douglas fir and the low value hemlock, the latter usually predominating. It is subjected to ocean fogs and rain even in the summer, and the number of fire-danger days is small. The usual logging practice at present is clean cutting, with highspeed (generally steam-driven) machinery, usually followed by intentional broadcast burning. While the fire danger in uncut timber or selectively cut timber is acute only occasionally, clean-cut areas or burned-over logged land will burn fiercely on a good many days in any summer.

Natural reproduction of the prevailing species, either in the open or in partial shade is profuse—provided there is a nearby seed supply. Hemlock is favored by moisture and protection; spruce, which is usually in the minority, seems to be favored by light and mineral soil. Red alder inclines to fill in the moister clean-cut openings and is a species not to be despised, but rather to be encouraged where it will make a good stand.

The measures which will insure leaving this type in reasonably productive condition are simple and quite sure of giving results.

CUTTING

Some form of selection cutting should be employed. This may be either tree or group selection, or a combination of them, which will remove the major part of the values from the stand, yet leave the nucleus for a later cut, provide an abundant seed supply of desirable species, and leave much of the area shaded with its virgin ground cover so that fires will be controllable.

Logging engineering invention has reached a point where some such selection cutting in this type is physically feasible. It may be done with crawling tractors, with some form of flexible, light, cold-decking machine, possibly roading with large, high-speed skyline machines, or with a combination of methods to fit the individual case that will make economic selection as profitable or more profitable than the present clear cutting.

No trees of which a considerable part is unprofitable to use should be cut. This leaves standing as full a cover as possible, and a minimum amount of unutilized debris on the ground.

A certain proportion of the tract may be clear cut, depending upon the composition of the original stand, but openings should not be larger than 40 acres, and not over half of the total area of the operation should be clear cut if this limitation on size of openings is to be effective.

SLASH DISPOSAL

Burning in this type is of questionable benefit, even temporarily. There should be no burning in areas where tree selection is practiced and a canopy of trees is left. Whether or not the clean-cut spots are burned will depend upon local hazard conditions and the opportunity to burn these spots safely. If their future hazard is high they should be broadcast burned or spot burned under conditions and with precautions that will prevent spread to the selectively cut areas. All snags in the clean cut spots and the taller ones in the selectively cut areas should be felled.

SPECIAL FIRE PROTECTION

The protection of logged land during and after logging must be more intensive than is the usual practice, for a period of about 10 years. It will take the form chiefly of preventing man-caused fires, but there must also be equipment and organization to suppress fires in their incipiency, and to do the burning that needs to be done intelligently and safely.

COSTS

The costs of the above measures will vary from tract to tract but are estimated to be less now in this type than as itemized in 1927.[1]

Selection cutting is not recommended unless it will give a realization per thousand board feet equal to that from clear cutting, or provide a reserve stand of sufficient prospective value to compensate for the difference. Therefore, assuming that an operator is organized for selective cutting or that it will pay him to so equip himself, there is no extra cost to such logging. The indications are that in most operations there will be a definite financial, as well as silvicultural, advantage.

---

[1] Munger, Thornton T., Timber Growing and Logging Practice in the Douglas Fir Region, U.S. Dept. Agr. Bul. 1493, 41 p., illus., 1927.

Slash disposal and subsequent protection on a more intensive and effective scale than at present should cost not over $1.50 an acre over present costs, or between 3 and 4 cents per thousand board feet. This presupposes a good job of disposal and 5 cents an acre spent annually for extra prevention and suppression measures for 10 years after logging. It should always be remembered that expenditures for really efficient protection of a property under operation may save the owner a much greater sum in standing timber and equipment preserved against a single bad fire.

THE DOUGLAS FIR TYPE PROPER

This type is ordinarily even-aged, and largely Douglas fir. As the stands become older they are invaded by shade-tolerant hemlock. The climate is such that the fire hazard is more acute and of longer duration than in the fog belt, both in virgin woods and in cut-overs. This type is less adapted to tree selection than the fog-belt forest. Reproduction of Douglas fir is prolific, provided seed is available and the site conditions have not become too unfavorable; but Douglas fir must become established in openings, as after clear cutting. Clear cutting, with high-speed machinery, is the usual logging practice.

A digest follows of measures which will insure leaving this type reasonably productive. These are given in detail in Department Bulletin 1493, already referred to, but are here somewhat modified in the light of subsequent information.

SELECTION CUTTING

A substantial part of all lands currently logged will be left with an adequate supply of seed if, under the principles of economic selection, only those trees, or more often groups and patches of trees, are selected for cutting that show a proper conversion value. Untouched patches of timber, from a few acres to hundreds of acres in size, will remain. These may be second growth on the border of merchantability, low-grade old growth, heavy admixtures of species at present inferior, or inaccessible areas hard to log now. Leaving uncut islands, strips and sidehills in this way, for economic reasons alone, has a most important silvicultural effect in that it breaks up the tract for better protection, provides a seed supply for a considerable part of the clear-cut areas, and tends to promote closer utilization on the land that is logged, thereby leaving less debris on the ground.

RESERVE STRIP

In another substantial portion of the Douglas fir type, where practically all the trees are profitable to cut, economic selection might result in clear cutting of large continuous areas. Even in the absence of slash fires many such areas will not reproduce satisfactorily because of lack of seed. To prevent devastation it is therefore necessary to adopt one of two alternatives: (1) Such modification of logging plans—staggered settings, logging alternate spurs, etc.—as will leave uncut timber standing adjacent to cut-over land long enough to reseed it; or (2) more permanent reservation (ordinarily for not less than 10 years) of uncut timber, in strips along watercourses or ridges, or in compact blocks, aggregating up to 5 percent of the area, but normally much less. In addition to providing seed, this standing timber, if strategically located, will reduce the chance that fires will run riot in the slash over great areas, or will reburn land already reproduced.

SEED TREES

Where areas more than 1,500 feet in width between timber that will stand for another decade are to be clear cut, a conscious effort should be made to leave seed trees singly or in clumps. These should be trees whose real conversion value will not amount to more than two or three dollars apiece. Where there are defective or low-grade trees in the stand, economic selection would indicate that these should be left standing.

SLASH DISPOSAL

The slash on clean-cut areas in this type should ordinarily be burned, but with precaution and judgment that will enable confining the fire to the compartment to be burned. Small bodies of logged land well isolated from causative agencies or well surrounded by uncut timber or firebreaks may be left unburned. The seed crop of the previous year should be given consideration when deciding when and where to burn. Broadcast burning is far from ideal, and steps should be taken to improve the technique of burning by some form of spot burning, possibly with machine piling and real control of the fires.

FIRE PROTECTION AND PREVENTION

All snags over 15 feet high and 20 inches in diameter should be felled on all logged land in this type. Debris about camps and along rights of way should be disposed of at the time of clearing to lessen the chances of fire starting. Protection of logged land during and after logging must be more intensive than at present. It should consist of more watchmen, more equipment, more water supply, more patrol, maintenance of means of travel over the areas, exclusion of the public, etc.

Colonization of small tracts in great logged-off areas should be discouraged. Areas to be devoted to timber growing should be classified as such and no encouragement given to farmers to settle on the incidental patches of good land that may exist. Such settlement increases the danger of fires from land-clearing operations and economically imposes a needless burden on the timberland owner for roads and schools.

COSTS

The costs of leaving douglas fir land productive instead of devastated are difficult to state, because of the difficulty of predicating just how effective the necessary measures will be. If such measures are not nullified by uncontrolled fires, their cost may be repaid many times over by assuring sustained yield to a company that must otherwise liquidate. A rough estimate of costs is as follows:

Economic selection cutting. This is a saving rather than a cost.

Leaving blocks or strips of timber to break up a big clear-cut area. With stumpage at $150 an acre, the reservation of as much as 5 percent of the timber might be a very expensive requirement for a private operator who was not definitely lined up for sustained yield. For one who was, the cost would simply amount to the delay in realizing on the reserved blocks or strips.

Four dollars and a half an acre, or the value of a little over 1,000 board feet of stumpage, might be taken as a regional average, between admittedly wide limits, for the timber so reserved. In every instance the uncut timber would have a high value as an aid in fighting fires, and the cost of reservation could not be charged wholly to stopping devastation. It is not uncommon for one fire to cause a single douglas-fir operator $100,000 worth of damage in standing timber and equipment destroyed. This is more than the cost of leaving strips of green timber to facilitate the protection of 20,000 acres.

Leaving defective or low-value seed trees. Usually no cost.

Better slash disposal. One dollar an acre, or 2.5 cents per thousand board feet logged.

Snag falling. Often done at present, at $3.25 an acre, or 8 cents per thousand board feet logged.

Cleaning up around camps and rights of way. Two cents for each thousand board feet cut.

Better protection during and after logging. Nine cents for each thousand board feet cut during the year and about 3 cents additional for each acre logged in the previous 10 years; total about 10 cents for each thousand feet of annual cut.

Avoidance of selling small isolated tracts to settlers is undoubtedly an advantage rather than a loss of revenue to any sustained-yield operator.

The above costs will vary so tremendously from one operation to the next that a summation of them for an average operation is largely theoretical; 22 cents for each thousand board feet cut, or $8.80 an acre, may be assumed for land on which economic selection is practiced. Unfortunately, their effectiveness cannot be positively predicted. Calamitous fires have occurred in spite of the expenditure by many operators of all that could reasonably be recommended for one or more of the prescribed practices. On the other hand, the practice of economic selection and the increase in effectiveness of fire protection may result not only in immediate savings to an operator, but also in placing him on a sustained yield basis.

WESTERN LARCH—WESTERN WHITE PINE TYPE

Important differences between the western white pine and the larch-fir forests of this type make it desirable to discuss them separately.

WESTERN WHITE PINE

The western white pine forest comprises an extremely complex mixture of species. The principal associates of the pine are douglas fir, western larch, lowland white fir, western red cedar, and western hemlock. Most of the white pine stands originally came into being as even-aged forests following fires. At some time between 160 and 200 years later the average stand begins to deteriorate. Decay becomes prevalent, and the loss from bark-beetle attacks may be very great. The white pine drops out more rapidly than most of its associate species, and by the time the forest is 300 or 400 years old, or even earlier, has generally disappeared entirely, leaving the shade-enduring hemlock, cedar, and white fir ordinarily very defective at this age. Most privately owned timber is younger and contains a high percentage of white pine, which is the most valuable species in the type.

Utilization of white pine is very close. Practically all trees 10 inches and over, breast high, are cut and logs are taken down to a 5- or 6-inch top diameter. One lumber company, however, with a considerable acreage of rather young timber has, after careful study, adopted a tree diameter limit of 12 to 16 inches, breast high. The utilization of other species is very far from complete because of their comparatively low value at present. Many operators are taking out only the white pine and the cedar poles, and leaving practically all of the other species in the woods. This residual growth represents a very good order of minimum productiveness. It is exceedingly rare that cutting in the white pine type does not leave either a large amount of residual growth or enough scattered trees quickly to seed the cut-over ground; some of the reproduction is likely to be pine.

Inasmuch as most white pine logging employs horse skidding, chutes, and railroad or river-drive transportation, rather than high-power machinery, this growth will survive logging if uncontrolled fires do not occur in the slash. Broadcast burning of slash has in the past been responsible for the devastation of hundreds of thousands of acres formerly in western white pine. A typical pine slashing is the most inflammable mass of debris that can be imagined. Broadcast burning of this dense tangle of slash, snags, and remaining trees reduces the fire hazard by probably not more than one year; after that inflammability increases rapidly because of the large quantity of material killed by the slash fire. The dead trees soon come down in a tangled mass and, together with a dense growth of fireweed, everlasting, and other vegetation, which becomes dry in late summer, form another serious fire trap. These old broadcast burns are almost certain to burn again either by fire starting in them direct or by fire spreading into them from burning operations in adjoining new slashings. Such repeated burning destroys not only all young residual growth, but also the larger trees required as a source of seed. The inevitable result is devastation.

The measures essential to keeping logged-over western white pine lands from devastation are adequate slash disposal and subsequent first-class fire protection. The latter has been described in the section "Protection Against Fire."

SLASH DISPOSAL

Piling and burning of not less than 75 percent of the logging debris is required to leave cut-over land in a condition of even minimum productiveness. The disposal of slash by piling and burning has been common practice in the national forests for many years. This method consists of complete lopping of the limbs from the top, piling in compact piles, and subsequent burning in the fall or spring. In some instances the slash is burned progressively by building fires and throwing the limbs on, thus making one operation of piling and burning. Either method properly executed results in a clean burn of the slash, with little or no destruction of remaining live trees or young growth, and the burning of not to exceed 10 to 30 percent of the surface area. Forest conditions on the area are not destroyed. Green trees are left green, and the typical moisture-loving vegetative ground cover of the forest is not replaced by inflammable firewoods, grass, and thistle, as after a broadcast burn. The duff cover on the ground is not consumed except where the piles are burned, which may be an important factor in obtaining white pine reproduction.

Great care in the burning of piled brush is essential, however, to keep the fire from scorching living trees or running over the ground between piles. A considerable degree of skill and judgment is required in selecting the proper time for burning. Conditions must be such that the piles are dry enough to burn, but that the ground surface is too damp for fire to run. Such conditions are most commonly found in the fall after the September rains.

COSTS

Large private operators who have believed in the efficacy of piling and burning as a method of protecting their standing timber have done a fairly effective job for their purpose at a cost of 40 to 70 cents a thousand ($10 to $17.50 an acre) under normal conditions. Under the influence of present conditions, one good job of private piling and burning is known to have been done for 36 cents a thousand. It is important to note, however, that the private owner is not concerned with occasional spread of fire that might partially injure residual growth. Altogether, it is probable that disposal adequate to prevent devastation can be effected at a cost closer to 40 cents than 70 cents a thousand board feet.

Most private operators who pile and burn slash in this way do so purely as a protection measure for their standing timber. They have been convinced that it costs less in the long run to pile and burn than it does to fight fires resulting from broadcast burns. One company, for example, has done good piling and burning since 1924 as a result of the very costly lesson it learned from fires in 1922 and 1923. These fires, spreading in slashings and old broadcast burns, covered 10,000 acres of virgin forest and entailed direct money loss of improvements, logs, standing timber, and fire-fighting costs which amounted to nearly $1,500,000. Up to about 1925 this company's cut amounted to approximately 300,000,000 feet. At the rate of 50 cents a thousand the slash resulting from this cut could have been piled and burned currently for $150,000. If piling and burning had been followed consistently from the beginning of the operation, there is every reason to believe that there would have been no serious fire losses.

Inasmuch as effective slash disposal in most instances is also the cheapest and most effective measure of protecting an owner's standing timber, there is often no slash-disposal cost chargeable purely to keeping the land productive.

It should be pointed out that although economic selection of trees to be cut, or any other change in usual commercial cutting practice, is not regarded as necessary to prevent devastation in this type (particularly larch-fir) it will often result in savings commensurate with cost of slash disposal.

LARCH-FIR

The larch-douglas fir forest has usually originated as an even-aged forest following fires, obviously not extensive enough to have destroyed all local sources of seed. Subsequent fires have opened up the original even-aged stand and have in turn been followed by reproduction in the openings and under the thinned stand. This process may have been repeated several times, resulting in several distinct age classes in the same area, sometimes in groups and sometimes with the younger age classes forming an understory to the older classes. This two or three-aged condition is very characteristic of the larch-fir forest.

The customary cutting and horse logging in stands of this sort, where small and large trees are intermingled, leaves standing a good many unmerchantable trees and some small growth. During the era of broadcast burning previous to 1925 in Idaho and before 1927 in Montana, uncontrolled fire in the slashings was followed by the same disastrous results as in white pine. Whether a single broadcast burn is followed by reproduction depends on the severity of the burn and the survival of possible seed trees. As a general thing, a great deal of young growth and many trees under merchantable size are killed. The dead trees subsequently make a veritable fire trap that becomes a source of danger in the future protection not only of the originally burned cut-over area, but also of adjoining virgin timber and cut-over land.

SLASH DISPOSAL

As in the white pine forests, adequate slash disposal, followed by intensive fire protection, is the key to keeping the larch-fir forest reasonably productive. Under the present laws, slash disposal in Montana is by spot burning and in Idaho by piling and burning. As spot burning depends on cleaning up large natural accumulations of slash, the result, even with careful execution, is the scorching and killing of a good deal of young growth and small trees surrounding the burned spots, leaving hardly more than half of the area in a green and productive condition. If done under dry weather conditions, spot burning often becomes a partial or complete broadcast burning. Piling and burning, if carefully done, is expensive, and if carelessly done it results in a broadcast burn. In general, no slash disposal at all is preferable to broadcast burning. There are many large areas of old cuttings in Montana in the neighborhood of Eureka, Kalispell, and St. Regis which have never burned and which are now, after a lapse of 20 to 25 years, comparatively safe from fire and well stocked with second growth.

In the face of modern hazards, some form of slash disposal is necessary. Partial disposal is the method recommended. The essential features of this method are piling and burning of slash only on certain strips of about 100 feet in width, and intensive patrol of the entire area of slashings for the 10 or 12 years required for natural reduction of the risk through decay. The main objects of the cleared strips are: (1) to reduce the chances of fires starting through human agency on the traveled parts of the area; (2) to afford clear lines from which fires can be fought; and (3) to break the area into blocks in which such fires as may start can be isolated. The strips will cover about 20 percent of the area under most conditions.

COSTS

The cost of slash disposal will range from 15 to 20 cents a thousand feet of cut, including the charge for the 10 or 12 years required for natural reduction of the slash as a menace. This is equivalent to

$2.70 to $3.60 an acre. It is important to note that this cost covers not only slash disposal, but protection of camps, logging equipment, and standing timber during the logging operation when an operator ordinarily takes measures of prevention regardless of whether he disposes of slash or protects his cut-over land. If this customary cost of protecting timber and logging property against fire loss is deducted, the charge for slash disposal becomes perhaps $2.

SUGAR PINE—PONDEROSA PINE TYPE

The territory covered by this type, as shown on the map, is also known as the California pine region, and embraces half-a-dozen locally recognized forest types or groups of types. Ponderosa pine is the most widely distributed and characteristic tree; sugar pine, douglas fir, white and red firs, and incense cedar are its common associates, named in decreasing order of value. Ponderosa pine, douglas fir, and true firs commonly occur both in pure stands and with the exception of red fir, in all possible combinations as well. A great range of sizes and ages, growing in intimate mixture, is a marked characteristic of the type.

The degree of cutting in commercial operations is naturally determined by merchantability of the species, among other factors. In such stands as pure ponderosa pine, cutting to a low diameter limit is common; while in mixed stands, with a high percentage of the firs, many trees of merchantable size are left. At the same time the amount of young growth under the mature trees is generally greater in the mixed stands than in ponderosa pine. Thus the tendency toward clear cutting is most pronounced where seed trees are most needed.

The most important fact to keep in mind when considering how to stop devastation in this type is that the establishment of ponderosa pine reproduction after cutting is a long and uncertain process. Ten to 20 years may elapse before even a fair stand of seedlings can become established from seed trees left by the loggers. Sugar pine, which has a higher board-foot value than any other species in the type, is even more difficult to establish than the ponderosa pine. Planting of either species is costly and undependable. The conclusion is unavoidable that, in the main, the preservation of young growth throughout the logging operation and in slash disposal is the principal means of keeping forest lands productive. If such growth is scanty or absent, or if it is subject to extreme danger from fires, provision must of course be made for seed.

Logging methods which a very few years ago spelled the doom of nearly all standing trees and young growth spared by the timber fallers have been recently abandoned in favor of much less destructive methods. Today about 85 percent, by volume, of the logs removed from the sugar pine-ponderosa pine forests are handled by caterpillar tractors, and only about 15 percent by high-power machinery (donkey engines and skidders). Proper regulation of tractor logging—that is, when it is so conducted that the area of roads and turning points is kept to a minimum, slashing of young trees is taboo, and the scarring of reserve trees is avoided—should keep the destruction of young growth below 25 percent on most areas. Avoidance of high-lead and high-speed machinery, and a determination to prevent all unnecessary damage in the use of other types of high-power machinery, will materially reduce the damage to seed trees and destruction of young growth once prevalent in the region.

The large quantity of slash and debris produced when stands yielding 15,000 to 60,000 board feet per acre are cut, added to advance reproduction and brush present before logging, gives cut-over areas in any type possibilities of fires far more intense, more damaging, and more difficult to combat than in the virgin forest. The minimum effect of slash fires is the destruction of advance reproduction and death of some immature trees. Such fires, moreover, do not completely consume the slash, and a fire hazard, which the burn aims to reduce, remains. The rapid invasion of worthless brush is also aided thereby and subsequent protection is made more difficult.

The following measures are necessary to stop forest devastation:

SELECTION CUTTING

In the sugar-ponderosa pine type an approach to economic selection has unintentionally come about at the present time because of a greatly depressed market. This has been a favorable factor in preserving forest productivity. As log values increase, however, under more favorable market conditions the tendency to cut to lower limits will again become evident, particularly affecting the valuable sugar pine and ponderosa pine. Under the principles of economic selection, cutting should be held strictly to trees that can be logged and milled at a profit. In the better stands on the west slope of the Sierras it is unprofitable under normal market conditions to cut pine below 24 inches diameter breast high. In east slope stands the lower limit of profit is probably 18 inches. For inferior species, such as white fir, the limit is of course much higher. Although the leaving of poorer species to compete with good is not desirable, it keeps the land productive by guaranteeing a merchantable second crop of some sort.

SEED TREES

Wherever in ponderosa pine stands cutting to the economic limit would not leave standing an average of at least four trees of ample seed-bearing size to the acre their equivalent in larger trees should be reserved from cutting. Ponderosa pines having the largest cone production per unit of merchantable volume are generally 18 to 20 inches in diameter, and this relative production is about twice as high as for 30-inch trees. From 1,000 to 1,500 board feet per acre in well distributed trees having good, vigorous crowns will usually be sufficient.

LOGGING

Logging should be carefully conducted so as to destroy no more advance reproduction than is absolutely necessary. Horse or caterpillar logging should be used on all ground adapted to it. High leads and the use of high-speed machines should be discontinued and other forms of high-power logging carefully regulated.

SLASH DISPOSAL

The slash disposal methods should be elastic enough to meet local variations in fire hazard, character of forest, and topography. In general a method of partial disposal is recommended, by which slash is thoroughly cleaned up around machine settings, log landings, and camps, and on strips along roads, railroads, ridges, and creeks to break up the area into compartments of about 100 acres. On these areas and strips the slash is destroyed either by swamper or progressive burning (burning as the felled trees are limbed), or by piling and later burning. The area covered may amount to 10 to 30 percent of the slashing.

SPECIAL FIRE PROTECTION

Better protection than is now usual on private lands is necessary for 10 years or more after logging. There should be an efficient, well-equipped prevention and suppression organization, fire lines must be maintained, and transportation routes must be kept open.

COSTS

There is obviously no cost attached to leaving in the woods, trees it does not pay to log and mill and often a distinct gain. Assuming a stumpage rate of $2 a thousand board feet, the investment in seed trees is $2 to $3 per acre. This is undoubtedly a maximum, and if the trees were barely over the merchantable limit the investment would be negligible. In most cases the value will be recovered with interest at the next cutting. Regulation of animal and tractor logging to prevent unnecessary damage to advance reproduction or young growth will cost little. Regulation of machine logging may cost 10 cents a thousand board feet, or $1,80 an acre. Partial disposal of slash will cost about 15 cents for each thousand board feet cut, or $2.70 an acre. Intensive fire protection will add about 75 cents an acre, spread over the 10-year period following logging.

The total of the last two items is $3.45 an acre. However, these expenditures may be the means of avoiding much greater ones. For example, in 1919 and 1920 one company logging in this forest type spent an average of nearly $10,000 a year on its cut-over lands for suppression of fires resulting from its own operations. In 1921, it started clearing along rights of way, with patrol following all trains, and its suppression bill dropped to less than $1,000 and total fire cost, including prevention, to $3,600. Practically every slash fire must be fought sooner or later, and usually by the operator. Any investment which prevents such fires, or facilitates their control, saves much larger investments in fire fighting.

Total costs under the most favorable conditions will include only the items of brush disposal and special fire protection, or $3.45 an acre. A maximum total of all items might rarely reach $8 an acre. The average is probably $4.50, or 25 cents a thousand board feet cut.

PONDEROSA PINE TYPE

This type, as will be seen from the map, has a very wide distribution, and some local variations in average size of the timber and heaviness of stand. The stands are ordinarily nearly pure ponderosa pine, and uneven-aged, although even-aged groups are common. Most of the type occurs on plateaus or gently rolling country. Where fires have been excluded for decades there is usually a fair understory of seedlings and saplings, but reproduction after logging is slow and on the less favorable sites uncertain. On some areas it has been kept out by overgrazing. Commercial cutting is not ordinarily as close as in most of the major types previously discussed. High-power machinery is used in some of the heaviest stands, but animal or tractor logging are far more common. Although the fire hazard is ever present, conflagrations, except in slash, are not common, and the control of fire, both before and after logging, is not exceedingly difficult.

The measures necessary to insure continued productivity in this type, in addition to the fire protection described in an earlier section, may be briefed as follows:

CUTTING

No trees should be cut of a size below the economic limit set by careful studies of the relative profitableness of large and small trees and of the probable future returns from those of small present value. Sound business practice indicates a minimum limit for saw timber between 15 and 20 inches in most parts of the type, but in a few localities and for products smaller than logs the limit may be less. Diameter-limit cutting coincides fairly well with good silviculture in this type. Each tract should be studied to determine the economic limitations for cutting, bearing in mind the growth and prospective value of the trees that might be left, in contrast with their present value. The inferior species, where present, would be cut very lightly. Such a cutting for saw logs only will leave a forest cover, the nucleus of a future cut, and enough seed-producers gradually to fill out the stand, on the great majority of areas. In Arizona, New Mexico, and adjacent territory, where advance reproduction is absent and thrifty trees below 21 inches diameter breast high are insufficient it will occasionally be necessary to leave 800 to 1,000 board feet in seed trees, per acre.

LOGGING

Because of the supreme need to preserve all young growth and unmerchantable trees against damage, all forms of logging should be very carefully regulated to this end. Even animal and tractor logging may result in unnecessary swamping out of roads, turning points, etc., and in damaging standing trees.

SLASH DISPOSAL

Slash disposal is necessary on a part only of each cutting area, as described under the same heading in the sugar pine-ponderosa pine type.

OTHER MEASURES

Similarly, better-than-average protection should be given cut-over areas. See the previous type.

Overgrazing should be guarded against. Moderate grazing, on the other hand, is a double asset in logged-off pine land; it helps the owner to defray the cost of carrying the land for continuous forest production, and tends to keep down the fire hazard of grass and brush, as well as competition of this vegetation with seedling growth. Experience has shown, as earlier emphasized, that a future crop of ponderosa pine depends even more on reproduction established before cutting than on that secured after cutting. This fact makes necessary especially careful handling of grazing with respect to seasonal use and number of stock, both for a few years before and a few years after cutting.

COSTS

Some lumber companies are already practicing the above measures practically as recommended, as a matter of good business. By so doing they have greatly decreased their fire losses, and added to the salability of their cut-over land. One company in central Oregon, for example, followed the method of slash disposal outlined; in 6 years it has had only 60 fires in an area eventually totaling 50,000 acres, and has confined these to 129 acres.

The cost of the measures, in excess of ordinary present practice, which gives little thought to leaving the land productive, or to increased returns from selective logging, is estimated to be as follows:

Sound economic and silvicultural cutting will be no more costly in the long run on a sustained-yield basis than the present heavy cutting and liquidation program. Trees that may have to be left especially for seed bearing constitute an investment recoverable in later cuttings of about $2.50 an acre.

Regulation of logging to prevent needless destruction need cost no appreciable sum if earnestly undertaken. A rare exception might be with high-power logging in heavy stands, where the cost would rise toward 10 cents a thousand board feet cut, or about $1.50 an acre.

Partial slash disposal will cost about 10 to 15 cents a thousand board feet, or 60 cents to $1.50 an acre above present commercial expenditures.

Additional intensive protection following logging may cost as much as $1.50 an acre, spread over a period of about 12 years.

Regulation of grazing involves no appreciable cost chargeable to stopping devastation.

The total cost will range from $3 to $6 an acre in different parts of the wide region where the ponderosa pine type occurs. All the maximum costs given under each item will not be necessary under any one set of conditions, but the items for slash disposal and special fire protection must be met throughout the type. As in the types previously discussed, savings resulting from the prescribed measures frequently compensate for their cost.

OTHER WESTERN TYPES

The redwood type, largely because of the tremendous capacity of redwood to reproduce from sprouts, is very rarely devastated. The lodgepole-pine type owes its escape from devastation by anything short of repeated severe burning to its abundant seed production, and to the pine's peculiar habit of retaining the seed on the tree for many years. A single fire in a cone-bearing stand may kill all the trees, but causes the cones to open and shower the soil with seed. The spruce-fir type may suffer devastation by cutting or fires, and particularly by a combination of them, but so little of either this or the lodgepole-pine type are in private ownership, and therefore subject to unregulated cutting and slash fires, that discussion of them is unnecessary here.

MEASURES TO BE APPLIED IN EASTERN FORESTS

The forest types of the East which now suffer extensive devastation are the longleaf-slash pine and the shortleaf-loblolly pine-hardwoods; those which suffer to some extent are the oak-pine, the white, norway, and jack pine-hardwoods, and the spruce-fir-hardwoods. Progressive deterioration, which ultimately leads to devastation, is taking place over the greater part of the remaining types. Here, as throughout this section, first-class protection against fires, insects, and disease is assumed to be in effect, since without it other measures to prevent devastation would be useless.

LONGLEAF-SLASH PINE TYPE

Longleaf pine, and to a lesser extent slash pine, characteristically form pure pine stands in both virgin and second growth. The area of virgin stands is now relatively small. Second growth is overwhelmingly even-aged over large areas, although comparatively recent fire protection is gradually beginning to make itself felt in the form of seedlings and saplings under all except dense stands of established growth. In spite of a remarkable fire resistance, longleaf pine is subject to complete killing in slash fires, and to severe losses from fires during the growing season. Slash pine is much less resistant than longleaf pine. Longleaf pine seedlings are destroyed by hogs on areas where the animals concentrate.

Cutting is generally preceded by turpentining, and in the eastern portions of the type turpentining is at present by far the most important form of utilization. Trees as small as 6 inches diameter breast high are still turpentined in spite of ample experimental evidence that the work does not pay. Cutting limits vary greatly. The minimum size of tree cut for saw logs is often 9 inches diameter breast high in virgin timber, and 6 or 8 inches in second growth, although here again repeated studies have demonstrated that such small trees do not return a profit. Logging, except in the comparatively small acreages of heavy virgin timber currently cut, is by animals.

The measures necessary to keep this type from devastation, in addition to the thoroughgoing fire protection described in the previous section of this report, are as follows:

CUTTING

Economic selection of trees to be cut—leaving uncut all those which cannot be utilized at a profit—will save many areas from devastation. Where clear cutting is economically justified, and little advance reproduction is present, seed trees must be left. In clear cuttings exceeding about 6 acres in size, or 500 feet in width, seed trees should be left at the rate of 4 to 8 longleaf pines, or 2 to 4 slash pines, per acre. These should be sound, thrifty trees, at least 10 inches diameter breast high with well-developed crowns. If the only available trees are turpentined or otherwise defective, the higher number should be left, because of the likelihood that they will be windthrown or broken. The seed trees should be well distributed over the area. Where the cutting is not clear, but leaves a nucleus of saplings and younger growth that will develop into a merchantable stand in due time, seed trees are of course unnecessary.

OTHER MEASURES

In turpentining operations, the same reservation of seed trees should be made.

In restricted portions of the territory occupied by the type, hogs are numerous, and should be fenced out of areas reproducing to longleaf pine; if a satisfactory stand of slash or some other associated pine may be expected, the fencing is unnecessary.

COSTS

Small trees which cannot be profitably removed from a stand at the time of cutting may include the necessary seed trees, and in general virgin longleaf pines 11 inches diameter breast high or smaller have no immediately recoverable value as saw timber. Trees as small as 9 inches diameter breast high have some turpentine rental value. In the event that larger trees have to be left, the investment in seed trees, considering both stumpage value and turpentine rental, may run up to $3 an acre, but will probably average more nearly $1. These values should be recoverable, with interest in the form of growth, at the next cutting or turpentining period.

Fencing costs to prevent grazing will vary greatly with the size of the tract to be enclosed. Hog-proofing an area of several thousand acres might cost 60 cents an acre in initial cost and upkeep for 10 years.

Total costs may run as high as $3.60 an acre, with a common average of about $1.60. Offsetting financial advantages that often result from the recommended practices are similar to those discussed for previous types.

SHORTLEAF-LOBLOLLY PINE-HARDWOODS TYPE

Devastation is chiefly confined to the saw-timber operations on the extreme western edge of this type. East of the Mississippi, ownership is much less concentrated, and in the Piedmont region farm wood lots are the rule. The ensuing discussion applies almost wholly to the west-Mississippi territory.

There is a much greater tendency toward all-aged stands than in the previous type, and, as the type name implies, toward a mixture of species. Relatively little pine still reman in virgin stands, which over considerable areas have been robbed of young growth by repeated fires. Where the pine is clear cut only a few decadent and worthless hardwoods remain. Even where a few pines survive logging, they are likely to be wiped out by fires in the slash. On the other hand bushy-crowned shortleaf or loblolly pines left standing on cut-over lands produce large and almost annual crops of seed, which is carried to considerable distances by the wind and in the absence of fire produces excellent stands of second growth. Shortleaf pine has the important ability to sprout from small stumps or roots of small trees killed above ground by fire.

Fire protection alone, of the degree already described, will go a very long way toward preventing devastation in this type, by permitting advance growth of both pine and promising hardwoods. The following measure is necessary to prevent devastation of such areas as have not yet a satisfactory advance growth.

CUTTING

Economic selection should be practiced as described for the longleaf-slash pine type. Where clear cutting is economically justified, there should be reserved for seed 2 to 4 sound, thrifty pines per acre, in all openings exceeding about 10 acres, and 700 feet wide between uncut timber. These trees should be not less than 10 inches diameter breast high and well-distributed over the opening. Occasionally such trees are not present in the stand, and their equivalent in larger trees must be left.

COSTS

Second-growth shortleaf and loblolly pines usually have no immediately recoverable stumpage value of 12 inches or less in diameter. Careful studies have shown that with an average stumpage value of $3 a thousand board feet, a common figure for second growth, only a few cents may be realized from a 13-inch tree. The cost of second-growth seed trees will, therefore, run from practically nothing up to about $1 an acre. In virgin stands this maximum might be doubled. For a general discussion of the compensating financial advantages to many landowners of leaving their lands productive, see the later paragraphs under "Total cost of preventing devastation of private lands."

OTHER EASTERN TYPES

In the absence of slash fires, the remaining forest types of the East are rarely devastated, in spite of very close cutting of the merchantable stand. There are three main reasons for this: The presence of hardwoods, capable of sprouting from stumps, or the base of fire-killed stems; the small size of the ordinary commercial cutting area; and the presence of advance growth of valuable species under stands allowed to reach maturity as saw timber or even of full pulp-timber size.

SOFTWOODS

Pure stands of softwoods are not as common as mixed softwood-hardwood stands in any type. They occur most frequently today as second growth on old fields throughout the oak-pine, the white, norway, and jack pine-hardwoods, and the spruce-fir-hardwoods types, and on cut-over land in the Lake region formerly in white and norway pine but now occupied by jack pine. These stands are normally even-aged. Provided fire can be kept out of the slash, clear cutting of all merchantable material in these even-aged pure softwoods does not eliminate the prospect for a merchantable stand in due-time, because cutting areas are no longer large and, in the all-aged stands, because young growth is already on the ground.

Slash from second-growth pine in the South rots very rapidly, but that from conifers of the North much more slowly. Twelve to fifteen years may be required to eliminate the hazard from slash of spruce and northern pines. This is so long a period of special hazard that the general system of fire protection, even though intensive, cannot be depended upon to cope with it in many areas. Some form of disposal must often be considered as a necessary step in preventing forest devastation.

The best form of slash disposal, from every point of view, is close utilization. If the trees can be used to a 3- or 4-inch top for pulpwood or any other purpose, no other disposal is likely to be necessary.

But if such close utilization is not possible, and large tops are numerous, they should be cleaned up on strips 25 to 100 feet wide along roads, railroads, around logging camps, portable mill set-ups, and similar special risks. Either piling and burning or progressive burning (currently, as the felled trees are limbed) are recommended. Costs of these simple measures will be considered under "Hardwoods" below.

HARDWOODS

When pure hardwood stands, or those containing more than half hardwoods, are heavily cut, they owe their usual escape from devastation chiefly to their ability to sprout. The virgin forests, the area of which is now small, have the additional advantage of an abundant advance growth typical of any all-aged forest. In spite of these advantages most hardwood forests have suffered greatly from a deterioration brought about by cutting which is very hard to distinguish from outright devastation. For examples of devastation it is necessary to go to hardwood lands which have suffered from one or more slash fires, such as birch-beech-maple-hemlock forests reduced to unmerchantable aspen and bird cherry, or oak-chestnut-yellow poplar reduced to scrub oak.

The chief hardwood types of the East are composed of a great variety of tree species, generally intermingled on the same area. Some species are valuable, others nearly or quite worthless. The valuable species vary from type to type, and no list can be attempted here. The worthless are such because of small size and poor form, even at maturity. Still other species are not of great value now, but attain such size and form as to hold promise of value under future conditions. Regardless of species, a rather high proportion of hardwood trees, even when young, are poorly formed; mature and overmature trees in many instances harbor serious decay. The volume of merchantable wood to the average acre of hardwood forest is therefore lower than in softwood forest growing on the same soil and in the same climate.

The remaining virgin hardwood timber is practically confined to portions of the river bottom hardwoods-cypress type; to the oak-chestnut-yellow poplar type on the least accessible of the southern Appalachian Mountains; and to limited areas of the birch-beech-maple-hemlock type in the Lake States, New York, and New England. Most of the second growth is as yet below full sawlog size.

Cutting for saw timber is rarely clean in hardwood forests; the section entitled "Current Forest Devastation and Deterioration" has described how repeated culling, first of the best species and individuals, later of the poorer, has been the rule. After each cutting more and more of the ground is taken in firm possession by the less valuable and dwarf species, which prevent the sprouts and seedlings of good species from developing. The succeeding forest is inferior even when the good species sprout vigorously, because in spite of very rapid early growth, sprouts mature at smaller sizes than trees from seed, and are subject to early rot. Thus on important areas repeated commercial cuttings finally reduce the productive capacity of the forest land not simply to zero, but to what might be called considerably below zero. That is, if culled hardwood land were planted with tree seedlings in order to produce a merchantable crop within reasonable time, the seedlings would often struggle in vain competition with worthless vegetation. Where this condition prevails a state of deterioration exists that is worse than devastation.

Such of the farm woodlands in the oak-hickory type of the Central and Lake regions as are not certain to be cleared for cultivation in any event, deteriorate seriously under excessive grazing. This deterioration is very similar to that resulting from long-continued fires in advance of cutting. Livestock, chiefly cattle, are allowed to pasture 6 out of 10 units of farm woodlands in the Central region and have browsed to death so large a percentage of the advance growth normal to the type that a heavy cutting of the older trees results in devastation. That is, if the woods have been pastured for many years even the youngest of the trees have outgrown their ability to sprout successfully from the stump. Exclusion of the stock for a few years after the cutting is in many instances futile, because the sprouts are too few to constitute the basis of a future merchantable stand; failure to exclude it almost always spells the doom of the scanty sprouts. Eventually, of course, heavy grazing by itself can devastate the oak-hickory farm woodlands, but the process could not be considered complete until so many of the mature trees had died from old age and other causes that the stand was unmerchantable. This is the ultimate prospect also faced by some of the oak-chestnut-yellow poplar forests of central Pennsylvania, now absolutely stripped of all young growth by deer.

To put a stop to serious deterioration in the hardwood types, the following modifications of cutting practice are necessary:

CUTTING

Postpone final cuttings in second-growth stands until there is a sufficient stand of seedlings of valuable species already on the ground, or enough seed-bearing trees of good species, to insure that the cutting will not prevent the ensuing stand from having a substantial portion—certainly not less than a fifth—of its volume in valuable trees of seedling origin. By final cutting is meant one that removes the main volume of the stand, as contained in the better trees. Thinning, or any type of cutting that removes only a part of the stand to improve the ultimate value of the remainder, or to encourage seed production and seedling establishment, is not included.

In the great majority of virgin stands there is abundant advance growth of good species, which in the absence of fire survives logging and, together with sprouts from the smaller stumps, forms an excellent second growth. In such virgin stands, and second-growth stands which are old enough to have an under-story of valuable advance growth, cutting may be clean if fire protection is thoroughly efficient. There are no better examples of satisfactory young growth than the unburned stands of northern hardwoods which have followed absolutely clean cutting for sawlogs and distillation of wood of virgin forest in Pennsylvania and New York.

It should be frankly recognized that second-growth hardwoods which may sometimes be profitably cut for pulpwood, fuel-wood, mine props, and other round products before reaching seed-bearing size may, over considerable areas, have no advance growth of valuable species. Such stands and their successors cannot be cut without eventual devastation of the land.

SEED TREES

In the absence of an understory of valuable seedlings and saplings, seed trees of good species should be left in cutting both virgin and later growths. This method of safeguarding the hardwoods stand against serious deterioration is, however, less certain of results than the alternative of deferred cutting already discussed. One to six trees in good seed-bearing condition, must be left to the acre. If their seed is such as to be widely distributed by wind or animals, one or two will do, but if the seed is heavy and not carried about by animals, five or six are necessary, They should be located where they will do the most good; for example, heavy-seeded species should stand above rather than below the openings which they are to seed.

GIRDLING

Scarcely less important on most hardwood areas than postponement of cutting until there is an advance growth of valuable seedlings, or reservation of seed trees from cutting, is the cleanest possible cutting of inferior species and of inferior individuals of good species. Groups of promising young trees of good species capable of good growth after logging should of course be left. But a heavy overwood of defective trees, themselves so crooked, limby, or decayed as to have no prospect of merchantability, will prevent advance growth from developing into a merchantable stand within a tree generation. This is particularly true where the advance growth is of tulip poplar, white oak, black cherry, and a number of others of the most valuable species, which can not endure much shade. If composed of inferior species able to endure shade, the defective stand will establish seedlings capable of competing with the good species already on the ground. The same overwood will render seed trees ineffective by covering the ground with litter which hinders germination of some species, such as tulip poplar and white pine, and by shading and starving the seedlings.

Complete removal of all large trees, except those required for seed or further growth, is probably an unattainable ideal of cutting. Every effort should be made, however, to find markets for trees too small or defective for sawlogs. Cross ties, mine timbers, cooperage stock, pulpwood, fuelwood, fence posts, and other small round or split products will be saleable from many acres. If, after the removal of every tree which can be made to pay its way, there still remains so heavy a worthless overwood that a devastating delay in development of a new and merchantable stand is inevitable, girdling, poisoning, or felling without utilization, of a few of the worst old trees is necessary. No fine or exact line can be drawn between girdling on a scale necessary to prevent serious deterioration, and on a scale which would promote a much fuller growth of good species. Girdling on the latter scale, weeding the young seedlings to promote a higher proportion of good species, thinning sapling stands, and similar cultural operations, are described under the next section of this report, A Program for Intensive Forest Management. It is improbable that on more than a small percentage of all hardwood lands cut over currently will girdling be necessary merely to prevent serious deterioration.

SLASH DISPOSAL

Disposal of hardwood slash to reduce the fire hazard after logging will be necessary only where fire risks are high, as sometimes along railroads, roads, around sawmills, etc. Because hardwood slash decays much more rapidly than softwood slash, high risks are decidedly rare. Partial disposal was described in connection with pure softwood stands, earlier in this discussion of "Other Eastern Types."

GRAZING

Protection against overgrazing of all hardwood land to be kept permanently in forest, is necessary for a period of about 10 years before and after any extensive cutting.

COSTS

It would be difficult to calculate the cost of postponing final cutting in a stand until the trees reach seed-bearing size. In general it may be said that hardwood forests promise a greater net profit if managed for the production of a main crop of saw timber or other large-sized material than if clear cut at short intervals for pulpwood, distillation wood, or similar small material. This is shown by the cutting policies adopted by public owners of forest land, and such private owners as look forward to permanent or long-term ownership. It should be remembered that the prohibition against final cuttings does not prevent either thinning out of small or poor trees, the absence of which will not appreciably lessen the prospects for seed production in the stand, or light cuttings to stimulate the remaining trees to produce seed.

Seed trees may often be below the economic limit for saw timber, and have no positive realization value for any purpose. The cost of leaving them under other circumstances may run up to $2 or $3 an acre, where trees well above the minimum diameter of 10 inches at breast height are the only ones available. On long-lived operations most of the seed trees will be cut in operations 10 to 25 years later, provided they have meanwhile produced a valuable young seedling stand. Their value can then be recovered, generally with substantial interest in the form of growth.

Close cutting of trees which have even a little realization value will of course add nothing to regular logging costs. In the rare instances where girdling or felling of unmerchantable trees is necessary merely to prevent serious deterioration, the cost would be from 50 cents to $1 an acre, assuming that not over 3 or 4 trees to the acre need be treated.

Cleaning up of slash along roads, railroads, and in other zones of special risk will vary greatly in cost, depending both on the type of forest and the degree of fire risk. In the southern Appalachians burning the slash and debris on a strip 66 feet wide along a logging railroad has been estimated to cost not more than $80 a mile, or $10 an acre of ground actually burned over. If railroads, roads, etc. were sufficiently numerous to require the similar clean-up or slash on one twentieth of a newly cut-over area, the cost here would be about 50 cents an acre for the entire operation. In the Lake States piling and burning, or progressive burning, of slash in zones of special fire risk is estimated to cost 25 to 40 cents a thousand board feet, distributed over the entire cut from a considerable area. The cost per acre might then be $1 to $2 an acre on hardwood saw-timber operations, and up to $6 on softwood.

It should be pointed out that no expenditure whatever for slash disposal is necessary on by far the greater part of newly logged-over lands in the East. Small cuttings, isolated cuttings, those in which the utilization of top wood is very close or in which only a small proportion of the trees are felled, are fairly sure to escape devastating fires if the general fire protective system is good.

There is no cost attached to regulating the number of livestock in the farm woods. On those farms where the pasturage obtainable in the woods is really needed it is obvious that the land is more valuable for agriculture than for timber growing, and will eventually be converted to the higher use.

As in some other types, the greater variety of conditions in these Eastern forest types makes a summary of costs rather meaningless. The cheapest forest to keep productive after cutting is that with abundant advance growth of good species; partial slash disposal is the only real item of cost, and averages, where necessary at all, $2 an acre. Where seed trees must be left, and some girdling of unmerchantable trees must be done, an additional $4 might be needed or $6 an acre in all.

NET COST OF PREVENTING DEVASTATION OF PRIVATE FOREST LANDS

In table 1 are summarized the measures, in addition to general fire protection, which have been described as necessary to keep forest land productive. These measures, or others much more intensive are already being taken on the national forests and most other publicly owned land, and their cost, if any to the public, is absorbed in the cost of general administration. The possible cost of putting the measures into effect on all privately owned forest land in the United States is estimated at $5,700,000. This is the possible approximate annual bill which would be presented to the forest industries if public opinion decrees that devastation of forest land in the United States must cease.

TABLE 1.—*Summary of modifications of or additions to usual practices (other than general fire protection) necessary to stop forest devastation of private lands*

Region and forest type	Logging practices	Slash disposal	Intensive fire protection	Miscellaneous
WEST				
1. Douglas fir type:				
a. Spruce-hemlock fog belt.	Economic selection cutting, taking only trees yielding profit. Up to half of area may be clear cut if no openings larger than 40 acres.	None in selection cuttings. In clear cuttings of high risk careful broadcast or spot burning. Snags felled.	During logging and up to 10 years thereafter.	
b. Douglas fir proper.	Economic selection cutting, with reservation of seed timber, either temporarily by staggered settings, etc., or permanently by leaving 5 percent strips or blocks on large clear cuttings. No openings over 1,500 feet wide without seed trees.	Careful broadcast burning, in small blocks. Snags felled. Debris about camps and along rights of way piled and burned at time of clearing.	------do------------	No colonization on large logged off areas permitted.

TABLE 1.—*Summary of modifications of or additions to usual practices (other than general fire protection) necessary to stop forest devastation of private lands*—Con.

Region and forest type	Logging practices	Slash disposal	Intensive fire protection	Miscellaneous
WEST—continued				
2. Western larch-western white pine type:				
a. Western white pine.		Progressive burning, or piling and burning, of at least 75 percent of slash.		
a. Larch-fir		Partial disposal, by piling and burning of slash on strategically located strips, or about 20 percent of area.	For 10–12 years after logging.	
3. Sugar pine-ponderosa pine type.	Economic selection cuttings, leaving 4 or more good seed trees per acre, 18 to 20 inches or 1,000 to 1,500 board-feet in larger trees. Animal or tractor logging where economically justified; in no case high-speed or high lead. Protection of young growth from injury.	Partial disposal, by progressive burning or piling and burning of slash on strips and high-risk areas, 10 to 30 percent of whole.	For 10 years after logging.	
4. Ponderosa pine type.	Economic selection cutting. In absence of advance reproduction, reservation of 800 to 1,000 board-feet in seed trees per acre. Careful regulation of logging to prevent damage to young trees.	Partial disposal, as for sugar pine-ponderosa pine type.	do	Regulation of grazing for several years before and after logging.
EAST				
1. Longleaf-slash pine type.	Economic selection cutting. In clear cuttings 500 feet wide, leave 4–8 longleaf seed trees, or 2–4 slash 10 inches or equivalent in larger trees.			No turpentining of seed trees. Hogs if numerous, to be fenced out of longleaf reproducing areas.
2. Shortleaf-loblolly pine hardwood type.	Economic selection cutting. In clear cuttings over 700 feet wide, leave 2–4 pine seed trees, 10 inches or equivalent in larger trees.			
3. Other types:				
a. Softwoods		Failing close utilization, partial disposal by progressive burning or piling and burning on high-risk areas.		
b. Hardwoods.	Hold final cutting until advance seedling reproduction of valuable species or seed trees are present or leave 1–6 seed trees of good species. Close cutting or felling or girdling of poor species or individuals.	As for softwoods, above.		Heavy grazing excluded both before and after final cuttings.

This figure, although necessarily an estimate, is based on a careful consideration of the many factors involved. The cost of specific measures, per thousand board feet, or per acre, have already been discussed under each of the major forest types. Figures given in the section Present and Potential Timber Resources, covering timber cut yearly for commodity use from the forests of the United States, supplemented by local Forest Service information as to stands per acre on lands currently logged, furnished the other factors necessary to the estimate. Where certain measures, such as slash disposal in the western white pine forests, have already been adopted by some of the operators in a region, because such action saves them money in the long run quite regardless of the future of their cut-over land, the type or regional cost is correspondingly reduced. If it were certain rather than probable that the remaining operators would find that the same measures pay, obviously no charge should be included in the regional costs. Their inclusion makes the total an overestimate rather than an underestimate. The same effect is produced by including the present value of timber reserved for seed, even though on a great many operations this value will be more than recovered in later cuttings. On the other hand an item of possible consequence which had to be omitted from the total because it could not be even approximated, was the cost of postponing final cutting in some eastern hardwood stands.

Whether the exact cost of stopping devastation of private forest lands would be somewhat over or under $5,700,000, it is clear that the sum involved is, nationally speaking, insignificant. It is about 1 percent of the sum spent annually in the forests of the United States to obtain the raw material—logs, cordwood, and other products—necessary for our forest industries.

Throughout the previous pages it has been stated that modification of logging methods to prevent devastation does not always involve a net loss. Economic selection, which was described as an important step in such modification in nearly every region, bars "boarder" logs from the sawmill, and saves money to the operator. The sums which a strict application of economic selection might save the forest industries in some regions is enormous. On the basis of selective logging studies at the Pacific Northwest Forest Experiment Station it is estimated that one third of the lumber cut in the last 10 years in the Douglas-fir region was obtained from trees too small to have a positive conversion value, and that the average loss per thousand board feet was at least $1. Assuming a normal production of 10 billion board-feet a year, the cost of cutting these small trees and thereby devastating a large part of the forest land on which they grew, is over $3,300,000 yearly. The sum is nearly twice as great as the estimated cost of stopping devastation or private lands in the same region. Although the savings possible in other regions are not so readily calculable, it is certain that they would be substantial, and that would go far toward meeting the cost of stopping devastation, if not actually exceeding it.

It should be emphasized that stopping devastation may have results reaching far beyond the mere assurance that a forest industry will not have on its hands a perplexing cut-over land problem, when it has completely utilized its present raw material. A common result will be extension of operating life and a great addition to profits. This will be particularly true in those forest regions were long-lived operations. even on a liquidation basis, are common. During every year that a plant can operate after the period allotted for the retirement of its investment, its profits are increased by nearly the amount of its former depreciation charges. If the timber for its extended operation has grown on its own lands, at no other expense than that of the intensive fire protection required to guard them against devastation, the profits are further increased.

Finally, it should be said that only a slight expansion of the extremely simple measures necessary to prevent devastation will, if applied to some operations in some regions, place them on a permanent basis. An example, described at greater length under the section Status and Opportunities of Private Forestry, is an industry owning about 80,000 acres of timber in the Pacific Northwest. If this tract is logged during the next 30 years according to the cutting practice now current in the region, it is estimated by the Forest Service that it will yield a profit of $450,000 over a mortgage of $3,000,000. But if economic selection is applied on a basis which leaves for growth and later cutting not only small trees which have no present net value, but also those which have less than a very high value, the tract will yield $2,800,000 over the mortgage, in the same length of time. Moreover, there will then be growing on it timber enough to yield 50 million board feet yearly, in perpetuity.

A PROGRAM FOR INTENSIVE FOREST MANAGEMENT

By Thornton T. Munger, Director, Pacific Northwest Forest Experiment Station

CONTENTS

Page
Introduction 1455
What constitutes intensive forestry? 1456
  Weeding, girdling, thinning, and pruning 1456
  Selective cutting 1459
  Refraining from cutting 1460
  Forest planting 1461
  Protection against injuries 1462
  Improved utilization 1463
  Developing transportation 1464
Need for intensive forestry 1465
Objectives for intensive forestry 1467
Selection of areas for intensive forestry 1469
Opportunities for intensive forestry in certain forest regions 1471
  New England and Middle Atlantic States 1472
  Lake States 1475
  Central States 1475
  South 1476
  Northern Rocky Mountains 1479
  Southern Rocky Mountains 1479
  Pacific coast 1480
Summary 1481

INTRODUCTION

In this section intensive forestry is considered from the standpoint of timber production only. On most of the forest area of the United States timber production will be the principal purpose of forest management. Management for this purpose will in large measure satisfy the requirements of other forest uses; but on some areas, especially in those large portions of the West where watershed protection, grazing, or recreational use is of first importance, intensive management will be governed by requirements other than those of timber production.

Intensive forestry is that forestry practice which aims to realize through silvicultural treatment the nearest practical approach to the maximum productivity of a given site, building up in the shortest practical time as large an annual cut as is consistent with the productive capacity of the land, or which aims to grow by particular effort some special quality of product. Under intensive forestry the whole of the area managed is in a growing condition and well stocked with desirable species adapted to each site, damage from fire and grazing is practically eliminated, and cultural measures are generally practiced both to utilize trees that under existing conditions are lost from decay, suppression, etc., and to improve growing conditions for the remaining trees. The application of intensive forestry is subject to economic limitations making it impractical to try to produce every possible foot of timber that might be produced with an indiscriminate outlay of money.

With the original stands of virgin timber practically exhausted in all the original eastern regions, the necessity for forest management to make productive use of much of the land area and to meet the Nation's need for timber is becoming increasingly evident. And, as has been the case with agriculture, under many circumstances it will be found that intensive measures to get maximum production per acre will prove more profitable than crude practices which realize only a small fraction of the productive capacity of the land. In Europe the forests yielding the highest returns are in general those on which practice is most intensive and most costly.

WHAT CONSTITUTES INTENSIVE FORESTRY?

The intensive forestry measures discussed in this section presuppose a system of fire control, disease control, and insect control that will largely eliminate losses of commercial timber and restocking stands. Such protective measures are discussed in preceding sections of this report.

Intensive forestry includes a wide variety of measures. Some of these have application in one region, some in another, and some in all regions. There are many variations of these measures to fit the local requirements of each forest type; these it is not within the scope of this paper to discuss. In some parts of the country, as in the hardwood types, the forests have not been actually devastated so much as they have been deteriorated by repeated cutting operations which removed the better trees, leaving the inferior species and the inferior specimens. Here the problem is to build up the growing stock and improve its quality by judicious selective cutting, thinnings, weedings, and underplantings. In parts of the South and West the adoption of selective cutting and the avoidance of premature clear cutting of young stands is needed.

The various elements of intensive forestry may be considered under seven headings:

WEEDING, GIRDLING, THINNING, AND PRUNING

Because of the large area of open and denuded land available for forestry, in the past much emphasis has been laid on the need for planting. Sometimes public interest in forest production has been directed almost exclusively to the need for planting, little attention being given to the great possibilities of increasing the quantity and quality of forest growth by cultural treatment of existing stands, especially during the early period of their development. Cultural treatment of young stands, including weeding, girdling, thinning, and pruning, is of double significance because it not only increases the productivity of natural second growth but may be absolutely essential to the successful development of plantations.

In certain forest types the competition between inferior and valuable species during the early stages is such that if the stand is not tended the latter will be suppressed and the stand will eventually consist largely of low-value trees. Such a situation may be prevented or remedied by the skillful removal of the undesired trees at the right time. This usually requires an initial investment, but ultimately yields a return to the forest landowner. It has been found in New

England, for example, that in young mixed stands of the almost worthless gray birch and the valuable northern white pine the latter is suppressed unless the birch is cut out, and that the benefits to the stand justify the expense in the long run. Similarly, weeding of young stands of spruce and fir in the Northeast to reduce the competition from worthless fire cherry, red maple, moosewood, etc., may substantially shorten the period required for the softwood species to reach merchantable size.

The mixed hardwood stands which come in so generally on clear-cut areas throughout the northern hardwood and oak-chestnut regions tend to be dominated by the least desirable species and can usually be greatly benefited by a judicious weeding when from 5 to 7 years of age. In the mixed forests of central New England, in fact, such weeding offers prospect of yielding a greater return on the investment required than almost any other single measure.

In the spruce-northern hardwoods region of the Northeast, culling of the more valuable softwoods in the past has left large areas occupied by overmature hardwoods which usually have large, spreading crowns and are often defective or otherwise unmerchantable. These worthless hardwoods occupy space which might be utilized by valuable trees and often overtop or suppress saplings or reproduction of desirable species. Girdling these worthless or low-value hardwood trees may immediately increase the current growth of a spruce and fir understory as much as fivefold. Such girdling operations cost not more than $2 per acre, and this investment will usually be amply returned by increased growth within a few years. Girdling of worthless hardwoods competing for space in the mixed stands will also stimulate the growth of spruce and fir of merchantable size; indeed, the increased growth on such trees is sufficient to warrant systematic girdling operations about 10 years in advance of logging in much of the spruce-northern hardwood region.

The outstanding example of the commercial application of girdling is to be found on a pulpwood operation near Glens Falls, N.Y. Systematic girdling of worthless hardwoods on lands cut over during the past 15 years and on areas scheduled to be cut in the next 8 to 15 years has been under way since 1926. Prior to January 1929, more than 5,000 acres had been covered at a total cost of about $10,000. In an experiment started at Corbin Park, N.H., in 1905, an understory of spruce and fir is showing a very remarkable response to release through girdling of overtopping hardwoods. Growth on the girdled area has been at least five times that on the ungirdled area. Here, twenty-five years after treatment, the girdled plot shows a stand of about 12 cords per acre of merchantable pulpwood with a current rate of increase of about 1 cord per acre per year, while the ungirdled plot shows a stand of less than 2 cords per acre. An experiment started in 1919 by the Eastern Manufacturing Co. in Maine demonstrates that girdling to release merchantable-sized spruce and fir may yield a profit of $2 per acre per year. In this experiment the girdling of all hardwoods down to a 2-inch diameter released 40 softwood trees per acre averaging 8 inches in diameter and having a volume of 272 cubic feet. After 11 years there were 160 merchantable trees per acre with a volume of 1,050 cubic feet, and the annual growth rate had increased from one seventh to three fourths cord per acre per year.

Thinning consists in removing from dense stands of timber a certain fraction of the trees in order that those which remain may grow more rapidly. Unlike weeding, the thinning operation does not especially concentrate on inferior species or specimens, but removes good trees simply to reduce the stand density.

Thinning not only stimulates growth but may serve to improve the quality of the product. It has been found that the most desirable quality of wood in certain hardwood species is produced when the growth rate is maintained within certain well-defined limits. Through thinning the forester may maintain a density of stand which will result in the desired width of annual growth rings and thus insure the desired strength or other technical qualities in the wood.

When the trees removed in thinning young stands can be marketed, the thinning may salvage material that would ordinarily be killed out in the normal struggle for existence. Thinning may thus make possible an early reduction of the forest investment, a result which is especially desirable in plantations. Wood supplied from thinnings may meet industrial needs for small-sized material, also, and thus make unnecessary the clear cutting of immature stands which under usual practices would be sacrificed for such purposes.

In certain types, of which lodgepole pine is a striking example, natural reproduction forms such a dense thicket that stagnation of growth results. Here a thinning operation even of unmarketable material may pay dividends by causing increased growth, especially if mechanical means can be developed for opening up the overdense stands of small trees.

At the present time very little of America's immature forest is systematically thinned; in Europe the practice is almost universal. Were America's forests more completely developed by roads, and were American forest owners and users better educated in the care of forest land, it would undoubtedly be recognized as profitable to do much more thinning.

An example of this type of cultural operation may be found on the property of the Superior Pine Products Co., near Fargo, Ga. In the last 3 years this company has thinned more than 2,500 acres of 15- to 20-year-old stands of longleaf and slash pine. The number of trees per acre has been reduced from between 600 and 1,200 to an average of 250. The operation cost about 50 cents per acre, but the company expects to realize a great deal more than that amount through accelerated growth and increased turpentine yield.

Pruning the lower limbs of valuable species like northern white pine in New England in order to produce higher-grade lumber has been found in some cases to increase the value of the pruned trees by $35 per 1,000 board feet. Pruning is recommended as a desirable practice in plantations and natural stands where improved quality will be so strikingly reflected in stumpage value. To be profitable and effective, however, pruning must be done judiciously. To keep the cost within reason pruning should be restricted to a selected number of the best and most promising stems, probably not more than 250 per acre in dense plantations. To be effective pruning should extend to the full length of the butt log and should be done when the trees are not more than 5 inches in diameter. This can usually be accomplished to best advantage in 2 or 3 operations at intervals of 3 to 5 years.

SELECTIVE CUTTING

Selective cutting will perhaps be the most important factor in restoring the deteriorated forests of the eastern regions to satisfactory condition. This is especially true of hardwood forests and of mixed stands, where the more valuable softwoods have often been crowded out by the hardwoods. On many areas in the older regions, growing stocks have been so reduced and deteriorated by successive clear cuttings that the opportunity for profitable utilization has been greatly lessened. On such areas, however, with intensive methods of utilization and marketing it may still be practical to make selective cuttings that aim to remove the least valuable species and the poorly formed or defective trees, leaving the most promising trees to grow to larger size. If in such treatment the quantity cut is always kept below current growth, the growing stock will gradually be restored and the total wood growth of the area will be concentrated more and more on stems of saw-timber size rather than wasted on brush and saplings that can never be utilized. Eventually, not only will it be possible to maintain much larger annual cuts but the quality or grade of the product will be substantially improved. Through such selective cutting it will be possible to convert many of the low-grade hardwood coppice forests of the East into the more desirable high forest largely of seedling origin.

Various modifications of selective cutting may stimulate reproduction of desirable species at the proper period in the life of the stand and in this way maintain uninterrupted production. By reserving as seed trees for final cutting the best trees of the most desirable species, selective cutting should gradually improve the composition and quality of the forest.

Detailed studies of operating costs in a number of forest types in widely scattered forest regions, including hardwoods in Michigan and in North Carolina, short-leaf pine in Arkansas, loblolly pine in Virginia, and Douglas fir and hemlock in Washington, have all shown that the cutting of trees below a certain size tends to reduce the average profit. Selective cutting is shown by these studies to result in the production of timber and logs averaging higher in value than those removed under clear cutting, to remove a relatively large part of the value of the stand in a minimum of volume, and to offer prospect of an early second cut and probable perpetuation of the forest on a profitable basis.

The results of selective logging of a 20-acre tract of northern hardwoods near Marquette, Mich., will serve as an illustration. At the time of cutting the stand averaged 6,350 board feet per acre, with 190 trees per acre more than 3 inches in diameter. In the selective cutting, which removed chiefly trees 22 inches or more in diameter, only 8 trees per acre were marked for cutting and only about 4 small trees per acre were knocked down. The cut averaged 2,250 board feet per acre, or 35 percent of the original stand. In addition an average of about 8 cords per acre of chemical wood with a stumpage value of $0.50 per cord was obtained. The cost of logging, including loading on the cars, was only $10.50 per 1,000 board feet.

As compared with an average price of $19 per 1,000 board feet obtained for logs in the ordinary clear-cutting operation in this vicinity, the logs from the selectively cut area brought an average price of $28.93 per 1,000 board feet.

The stand left contained 41 trees per acre between 12 and 22 inches in diameter, and it is estimated that another cut of similar volume and value will be feasible in perhaps 20 years. In that case the average annual return per acre, not including interest and other carrying charges, will be about $2.50 per year.

Recent studies reveal very strikingly the economic advantages of selective cutting in types where it formerly was not thought practicable. It is the most practicable and effective way of converting nongrowing mature forests immediately into stands with a realizable net increment. In certain types where clear cutting has been in vogue, as in the Pacific coast spruce-hemlock, in redwood, in some Douglas fir types, in western white pine of Idaho, and in the southern pineries, a change to some form of selective cutting would have a profound effect in increasing regional growth. In the spruce-hemlock type of the Pacific coast a recent study showed that selective cutting, with a modification of logging methods, gives an average net return higher by $1.26 per 1,000 board feet than that obtained by the conventional clear cutting, and that when the entire property involved has been cut over the stand left by selective cutting will be ready for another cut. For a given volume of cut, obviously, selective cutting must extend over a larger area than clear cutting, but it tends to transform the stagnant old forest to growing condition more rapidly and eliminates much of the uncertainty as to prompt regeneration that clear cutting involves.

Under all conditions selective cutting adds much less to the fire hazard, which in all regions is very intense for a few years after logging on clear-cut areas. Careful measurement of moisture conditions and fire hazard in several forest types has shown that even a light canopy greatly reduces the period of extreme fire danger. In zones of especial hazard this factor may be the most important consideration in selective cutting. The reduction of fire hazard on selectively cut areas is a form of insurance which may well justify on its own account whatever extra investment the process involves.

REFRAINING FROM CUTTING

The ax is the chief tool of the silviculturist for increasing forest production, but there are cases where the most imperative forest practice is to refrain from cutting. Forest owners, eager to reap any possible returns from their properties, are disposed to cut young timber when it is still at the zenith of its rapid growth and before it has reached the best of its quality production. This not only depletes forest capital and prevents realization of the maximum periodic increment but may result in idle land, for such young stands may not have begun to bear much seed and so may not be capable of natural reproduction. Owing to premature cutting of young stands there is a dearth of large saw timber in the Eastern States. The forest area has a growing preponderance of small trees and brush, and lacks a normal distribution of age and size classes suitable for giving a sustained yield of saw timber. When it is no longer so easy to import saw timber of good size from the virgin timber regions of the West, the deficiency of larger timber in the eastern forests will be keenly felt by the eastern consumer.

In parts of the South particularly there is a growing practice of going back on the older logged lands and cutting the infrequent small trees that are merchantable for any purpose, thus both sacrificing fast-growing trees and robbing logged areas of their only seed supply.

Recent studies indicate that premature cutting of small trees is very often directly contrary to the self-interest of the lumberman-owner. A more enlightened understanding of the financial aspects of timberland ownership and timber growing should lead private owners to postpone cutting which will yield a relatively small immediate revenue for the sake of getting a much larger return later and thereby realizing a larger interest rate on the forest capital. Too often the urge to get quick returns outweighs the expectation of greater returns in the future. This should not be the case with public and quasi-public agencies, which should never cut young timber prematurely on the lands under their control.

Another type of premature cutting is wasteful cutting of old-growth timber in some of the western forests. Here gross overcutting has been precipitated by timber speculation, by uncoordinated effort, by employing poorly conceived methods of lumbering, and by the pressure of carrying charges. It is calamitous that the Pacific coast forests should be cut so wastefully now, to the detriment of a saturated market, when a few decades hence the Nation will need this timber so sorely. Wise, farsighted public policy would dictate that much of this timber should not be cut now. How shall it be avoided? It has been proposed that in the three Pacific Coast States there be large-scale public acquisition of private forests, in order to help counteract wasteful exploitation and conserve this virgin timber for the future. This would be in a sense a measure of intensive forestry, for it would attain by indirect means an enlarged sustained production for the whole Nation.

FOREST PLANTING

Since intensive forestry proposes that the entire area be well stocked with desirable species, it involves planting of denuded and under-stocked lands. The need for planting of denuded and open lands available for forestry is discussed in a separate section of this report. In addition, planting is sometimes desirable as a method of regeneration after clear cutting and of raising the quality or volume of the production of degenerate stands. In most of the forest regions of this country intensive forestry practice will depend upon natural reproduction to keep the land productive, but this will not always be adequate. Some areas will only partially restock and on some areas there will be fail places. In such instances, natural regeneration should be supplemented by planting.

In the California redwood region, for example, a region of exceedingly high potential production, the sprouts from the redwood stumps restock only about a third or a quarter of the area. If the conventional clear cutting is practiced and seed trees are not left, as is now the usual practice, the blank areas should be planted with desirable trees. This has been done on a considerable area of private lands. In the Douglas fir region, likewise of high potential production, planting should sometimes be used on clear-cut areas as an adjunct to natural regeneration to get the maximum out of the land. This is already being done on the national forests and by two private corporations on their own high-quality lands.

In certain portions of the eastern hardwood types the forest has degenerated, as a result of repeated cutting, until the better species are largely eliminated and only a degenerate sprout forest remains. Also some forest land bears only naturally inferior species, such as the scrub pines, where better species might grow. In such cases, if the potential production of the land warrants the investment, conversion of the inferior stand to one of greater intrinsic value by planting is indicated, either through under planting or through planting and weeding following clear cutting. On several of the State forests on the coastal plain of southern New Jersey, supplementary planting of this kind has been undertaken on a large scale. On perhaps half a million acres in southern New Jersey the natural forest has degenerated into a poor-quality sprout growth of mixed oaks which seldom yields more than 10 cords of wood per acre. If these stands are clear cut after they have lost their early vigor, a satisfactory mixed forest can be established by carefully planting 300 to 400 pines per acre in the larger openings between the sprout groups. Short-leaf and loblolly pines have proved most satisfactory for this purpose because of their rapid early growth, which enables them to keep up with the oak sprouts and minimizes the need of subsequent cleaning. On these State forests the initial purchase price of the land was $3 to $4 per acre. A net return of $10 per acre was obtained from the sale of the oak cordwood. Planting cost from $3 to $5 per acre, and subsequent cleaning cost not more than $1 per acre. As the mixed stands started in this way develop, the oak sprouts may be cut for fuel to create more favorable conditions for later growth of the pine.

PROTECTION AGAINST INJURIES

The safeguarding of the forest against injurious agencies is a basic necessity of intensive forestry. Previous sections have discussed protection against fire, insects, and disease. In some parts of the country forests require another form of protection, namely, against the overgrazing of livestock and more rarely of deer. The forage in a forest is a product that should, if possible, be used; but its use must be reconciled with timber production, and the major use not sacrificed for the minor.

In the Central States hardwood region, for example, the tree-shaded pasturage of farm woodlands is a useful resource, but the grazing of stock in such woodlands is not good for timber production. Where the heavy grazing of domestic stock is exceedingly detrimental to forest growth and prevents adequate regeneration it should be taboo, unless the use value of the pasturage is greater than the loss in timber production.

In some of the western coniferous types like ponderosa pine, successful forestry requires that grazing use be checked for a period of years before or after cutting, or both.

In parts of Pennsylvania and in some other places, deer have become so abundant that they interfere with full forest productivity by cropping the undergrowth, coppice sprouts, and seedlings. There is no reason why game production should be incompatible with intensive forestry, but game management should be gaged to prevent undue detriment to the forest crop.

There are other special problems of protection that must be met to attain full productivity. For example, rabbits sometimes do serious damage in plantations, less often in natural stands. In many parts of the country porcupines have become so numerous and feed so destructively on the bark of forest trees as to cause serious loss of forest material and forest productivity. Such pests must be controlled on areas designated for intensive forestry. Less conspicuous, but perhaps equally serious, is the damage done by the small rodents that feed on seed or seedlings, often materially retarding natural regeneration or ruining plantations. Intensive forestry may in some cases necessitate artificial control of these pests.

IMPROVED UTILIZATION

Under the conditions usually surrounding commercial timber operations at present, it is not possible to remove all the usable material at a profit. Considerable portions of the felled trees are left in the woods unutilized. Other trees containing usable material are left standing, not as the nucleus for a future cutting, but simply because of lack of development of economic outlets, and being a prey to fire and wind are usually wholly wasted. Still more wood is lost to use in the process of manufacturing. It should be the aim of intensive forestry to counteract this waste. If the forest and individual trees are imperfectly utilized, a larger area must be cut over to supply the country's requirements. This waste of the forest resource is due in some regions, notably in the Pacific Northwest, to exploiting timber that is not "economically ripe" and to clear cutting extensive areas containing trees of high, medium, and low value at a time when market conditions justify cutting the high-value stumpage only. It is estimated that a third of the volume of the Pacific Northwest timber felled in the last 10 years has been handled at a loss. It is felt that economic selective logging, where physically possible, will go a long way toward avoiding the felling of trees that should not be felled and improving the utilization of those that are felled.

More frequently inability to utilize timber resources fully at a profit is due to failure to develop means for the manufacture or marketing of all the products. Some sawmill operators, for example, are concerned solely with the production of sawlogs of conifers and ignore the possibilities of cutting poles, pulpwood, posts, firewood, or other minor products. This is something that intensive forestry should correct by developing a market for all products, integrating all the wood-using industries, and then assuring that where cutting is done utilization will be complete. Notable progress has been made in the last decade or two, particularly in the East, the South, and the Lake States, in attaining better forest utilization through the upbuilding of wood-using industries, the introduction of various pulping processes, an increase in the efficiency of small mills, and the introduction of conversion processes for chemicals, fuels, and other by-products. In regions of heavy forest depletion where wood-manufacturing plants have closed down the local agricultural or urban communities have come to use less wood, and the markets for such supplies of forest material as do exist have been lost. This prevents good use of the forest and its by-products. The maintenance of well-integrated forest industries will help to restore a market for forest products that in turn will promote intensive forestry.

A development of utilization technic, through research or otherwise, that will find a market for all species of woods and dimensions of lumber will make possible a closer use of the forest, the sale of thinnings, the avoidance of high grading the forest, etc. Too often now the better species are cut where the inferior might do, or wide lumber only is salable where small squares cut from the top logs or from thinnings might answer the consumer's purposes.

DEVELOPING TRANSPORTATION

Roads of one sort or another are one of the permanent needs on areas to be devoted to intensive forestry. The yield of a forest cannot be realized without roads to take out the product; thinnings and improvement cuttings can be made if there is an outlet for the product, but cannot be afforded otherwise. In western Europe it is considered axiomatic that there cannot be real silviculture without roads by which all parts of the forest may be reached by log-transporting devices so that salvage cuttings, thinnings, and major cuttings can be made wherever and whenever needed. The installation of a permanent transportation system, particularly on public lands where the stumpage is sold on bid, makes it easier in parts of stands, at least, to sell stumpage under terms and in quantities that will promote the best silviculture.

In many types of forests largest yields of high-quality material are obtained by removing a relatively small number of trees per acre in any one operation but going back over the same area at short intervals, often not more than 10 or 15 years. Such operations are impossible without a permanent transportation system. Likewise, with a road system established to harvest major products cultural operations can be made and minor products harvested profitably. In this way it may be possible also to harvest and utilize trees which otherwise would die or deteriorate as a result of suppression, insects, or disease, or trees uprooted or broken by storms. A permanent road system may make it possible also to stamp out by immediate cutting incipient outbreaks of destructive insects or disease which otherwise could not be controlled in any practical way.

In many sections of the Northeast existing public roads supplemented by old woods roads, many of which may readily be kept open or made passable for automobiles and trucks, make practically the entire forest area accessible for intensive operations. Under such circumstances intensive forestry can proceed with a minimum of preliminary construction. On some of the State forests in Connecticut considerable progress has been made in the past few years in reconstructing and extending the system of woods roads dissecting the area. The existence of these roads enabled the State to take excellent advantage of unemployment-relief appropriations to further the weeding, thinning, and improvement of many areas on which these operations could not otherwise have been carried out.

Another example of the effect of roads in making possible intensive forestry practice exists on the Shasta National Forest, Calif. A large block of this forest had been cut over before its acquisition by the Forest Service. In certain remote canyons pockets of overmature, decadent, and insect-infested timber had been left standing. After building several roads across the area for fire-protection purposes the Forest Service was able to salvage the timber in these pockets, which otherwise would have gone to waste. The returns realized from the stumpage were sufficient to pay a large share of the purchase price of the entire area, and the stand was left in condition for much more satisfactory growth. Without roads such an operation would have been impossible.

The possibilities are further illustrated by Forest Service cost studies made on the property of one of the largest lumber operators on the Pacific coast, who is planning a system of permanent truck roads. The studies indicate that the saw timber, which the owner intends to harvest by a system of economic selective cutting, will liquidate the cost of these roads, their maintenance, and the interest on the investment during the life of the saw-timber operation in addition to bringing a profit greater than could have been realized by the usual method of cut out and get out. The permanent roads, entirely liquidated, will then enable the operator to make, without any transportation charges, thinnings and cuttings that will unquestionably yield a greater volume of material than he could have recovered without permanent roads and that will leave his growing stock in better condition.

Whenever forest roads are built, whatever the primary purpose, they should be constructed with a view to making the largest possible area available for cheap exploitation and transportation of forest products. Some forest areas, like portions of the southern pineries and of the ponderosa pine forests, are so open that lack of secondary roads is not serious, but in many parts of the country lack of transportation in the forest zone is retarding effective utilization of mature timber and preventing silvicultural treatment that would improve the forest.

NEED FOR INTENSIVE FORESTRY

In the section Present and Potential Timber Resources and also in the section The Probable Future Distribution of Forest Land Ownership it was pointed out that in the natural course of events intensive forestry may be expected to develop on certain areas simultaneously with the application of extensive forestry on other areas and with the extension of simple protection to cover adequately all forest lands. The Federal Government, a few of the States, several communities, and some of the more progressive public-service companies and other private owners are already applying intensive measures on at least part of their properties in order to realize more completely the potential production of the land. Although the areas under such management at present do not constitute a very impressive total, they are scattered throughout almost all the important timber types of the country and represent a wide variety of soils, topography, and economic conditions. We may expect that the proportion of the total timber-production area under intensive management will increase considerably as the need for intensive forestry becomes more clearly recognized.

Intensive forestry is needed to produce the better-quality materials which are likely to be especially scarce in the future. Under prevailing practices, second-growth timber is usually cut at a relatively early age and yields very little material of high quality or large dimensions. Usually, because of its poor quality, lumber cut from second-growth stands is for the most part useful only for ordinary rough construction. Only a small fraction of the total goes into millwork or specialty products, which bring the best prices. This is perhaps equally true of hardwoods and softwoods, although second-growth hardwoods, because of rapid growth, are often better suited than old growth to certain uses requiring strength.

Then there are a large number of special products the material for which is not likely to be produced without planwise management. Poles and piling require material of special dimensions and qualities which are afforded by relatively few species. Clear hardwood finish and flooring, veneers, and specialty products like insulator pins, shuttle stock, handles, and shingles, all require material of certain qualities or dimensions which in the future will have to be provided largely by intensive forestry.

The conditions likely to prevail if intensive forest management is not adopted are illustrated by many forests in the regions where uncontrolled cutting has been in progress for the longest period. Many of the eastern forests have deteriorated in quality owing to repeated culling of the better species. It is a great economic loss to have inferior hardwoods, for example, growing where valuable hardwoods or choice conifers might be growing. In the Lake States are great areas now occupied by weed trees like aspen that should be converted into productive forests of good species. In spruce-hardwood, spruce-hemlock, and spruce-fir mixtures it is usually good business to augment the proportion of the much more valuable spruce. Ordinarily, intensive forestry practice will be required to improve the composition of mixed forests; in most cases it may be expected to pay well in the long run.

Intensive forestry practices are needed not only to produce timber of desired species but also to produce trees of desired form and quality. Straight, clear-boled trees free of injuries are much more valuable than the average run of trees in unmanaged or poorly tended woods. By proper spacing of trees through selection cutting and thinning it is possible to grow wood of the density, or number of rings per inch, most desirable for special uses. In certain regions the pruning of trees to make clear logs, judicious thinning to favor the best-formed trees, and to give ideal spacing, interplanting of gaps or underplanting with desired species, and special measures to minimize deformities caused by insects would all help to raise the quality of the product.

Only by managing the forests on relatively long rotation as well as by applying these cultural measures in young stands can timber of high quality be produced. Selective cutting planned to carry a certain number of trees per acre to large size will perhaps facilitate the production of high-quality material as much as any other measure. In any event, not much high-quality material can be expected without forest management going considerably beyond the practices which aim only to insure maintaining production in sufficient quantity for commercial utilization.

As an accompaniment of intensive forestry to obtain growth in sufficient quantity and of satisfactory quality for the Nation's needs, it will be necessary to build up the growing stocks of forests in the eastern regions to at least two and one half times their present volume. The supply of virgin timber in the West will serve to bridge the gap, at least in part, for the immediate future, but continued uncontrolled liquidation in the West may, within a few decades, endanger the ultimate productive capacity there also. An adequate growing stock is the first essential in maintaining an annual cut commensurate with indicated requirements. Depletion of growing stocks tends to divert cutting into stands of smaller and smaller timber, with an accompanying deterioration of the composition of the stands and a lowering of the quality of the product. Under this process the productive capacity of the land is largely wasted in the growth of brush, which precludes full use of the land by valuable species, or of small stems which die out before reaching merchantable size. The volume of wood which a given area is capable of producing each year will be much more valuable if concentrated in large measure on stems of saw-timber size than if diffused on young growth or brush. Intensive forestry accomplishes this by eliminating the less valuable trees early in the development of the stands and by maintaining a sufficient growing stock to convert a large portion of the potential annual growth directly into usable material of large size and high quality. Adequate growing stock is one of the main objectives of intensive forestry, and without it anything approaching full realization of the growing capacities of the land cannot be attained.

OBJECTIVES FOR INTENSIVE FORESTRY

From the public standpoint the objective of intensive forestry will, of course, be primarily to meet the needs outlined in the preceding paragraphs. In brief, intensive forestry will aim by systematic management, selective cutting or its equivalent, cultural measures, and adequate protection to build up and maintain the growing stocks in order to produce timber in sufficient quantity and of required quality to meet the prospective national needs.

From the viewpoint of private owners the objective for intensive forestry will be to increase and stabilize the income which may be derived from forest properties. Practices which make fullest use of the productive capacity of the land within the limitations of local economic conditions and under which the growth takes place in timber of large size and high quality will generally prove the most profitable. The possibilities for intensive forestry by private owners are discussed more fully in the section Status and Opportunities of Private Forestry.

In the section Present and Potential Timber Resources it has been estimated that normal domestic timber requirements for the future may be expected to total about 16.5 billion cubic feet per year, which is almost the same as the total annual drain on the forests for the period 1925–29. In addition it was stated that a margin of safety of at least 1 billion cubic feet should be provided in order to take care of catastrophies which might cut down future production. It is quite probable that a satisfactory export market will be available for a considerable production in excess of these requirements.

In the section referred to, present annual growth on the entire 432 million acres now in commercial timber production was estimated as a little less than 9 billion cubic feet. But since it has been suggested in other sections, as summarized in the section The Area which Can and Should be Used for Forestry, that 41 million acres involved in that estimate may be either cleared or reserved for other uses, it appears that the present current growth on lands available for future timber production may be only about 8 billion cubic feet. In that case almost 10 billion cubic feet of additional annual growth must be provided to meet the estimated national needs.

Part of this additional growth would come from the reforestation of lands now idle and nonproductive; part would result from more efficient protection of the forests from fire, insects, and disease, and the extension of such protection to all forest lands; part would result from the stopping of forest devastation; and part would be attained by the practice of intensive forestry throughout the country on a large scale.

In the discussion of the ultimate achievement of the program to put all available forest lands to productive use, in the section The Area Which Can and Should be Used for Forestry, it was estimated that a reasonable balance in forest management would involve intensive forestry on perhaps 100 million acres. Such an area would probably produce about 6⅔ billion cubic feet of timber per year. Under the plan outlined in that section for simply meeting the indicated national timber requirements, intensive forestry might be needed on only 70 million acres. If the latter program is to be achieved by the end of the present century, the area under intensive forestry must be extended by about 1 million acres per year. This may be considered the minimum objective. To achieve the program suggested for complete land utilization in the same period of time would require extending the area under intensive forestry by about 1½ million acres per year. On the basis of opportunity and need, the total area suggested for intensive forestry under each of the two programs may be distributed by regions as follows:

Region	Plan for complete land utilization	Plan for meeting estimated timber requirements
	Million acres	*Million acres*
New England	7	5
Middle Atlantic	8	6
Lake	20	11
Central	15	10
South	40	30
Pacific	8	7
North Rocky Mountain	1	.5
South Rocky Mountain	1	.5
Total	100	70

The possible means by which the needed area may be brought under intensive forest management are, in a broad way, as follows:

(*a*) Extension of intensive practice on existing public forests.

(*b*) Acquisition by the public of private lands which in private ownership are not fully productive but which may be made so if brought under public control.

(*c*) Demonstration on experimental areas of the economic possibilities of intensive forestry, and education of forest-land owners to an appreciation of these possibilities.

(*d*) Continuation of study and stimulation of action directed toward the removal of handicaps to forest management, such as inequitable methods of taxation and lack of commercial insurance, in order to place forestry on the same plane as other business enterprises.

(*e*) Assistance to private owners, such as public cooperation in fire prevention and in the establishment of credit agencies, so that timber growing will be made more attractive to private capital.

(*f*) Public regulation of private land-management as to timber cutting, grazing, and control of insects, disease, and fire.

Public action and leadership along the lines suggested should result in an early and rapid change of attitude on the part of private timberland owners, which in the long run should result in widespread adoption of intensive forestry measures on private lands. The necessity for public regulation, and the stringency of regulation if it is resorted to, will depend largely on the success of the other measures listed above.

SELECTION OF AREAS FOR INTENSIVE FORESTRY

It should be a fundamental guiding principle in the formulation of a forestry program for the country that it is better business practice to concentrate effort on a restricted area and get eminently satisfactory results than to diffuse the same effort over a large area and get proportionately less satisfactory results. This is due to the fact that many of the costs of forestry, such as those of administration, protection, and road building, either are largely independent of the productivity of the land or are higher on the poorer, rougher, and rockier areas than in the more favorable situations. It is more profitable to concentrate activity first where yields per acre will be relatively high and operating costs relatively low.

The Wisconsin Committee on Land Use and Forestry, for example, recognizes the impracticability of attempting to put all the forest lands of the State under intensive management at once and instead proposes to concentrate first on possibly 2 or 3 million acres and develop them as highly productive forest properties. The remaining area contains a large acreage of poor land, which the committee recommends [1] should "be policed; protected from fire; kept free as possible from settlement in order to obviate the building of highways, organized school districts, and other local improvements."

This committee, in distinguishing between areas that should have intensive forest management now and those that merit only protection from fire for the present, recommends for Wisconsin that public agencies "coordinate their efforts and concentrate on selected areas, and thus be able to achieve tangible, concrete results in a short time. * * * As time goes on and economic conditions justify, the same intensive practice may be extended to other areas within the State. Six or seven million acres of intensively managed forests are worth more than 16 million acres of poorly protected, wild, cut-over lands."

Granting that intensive forestry effort should be concentrated rather than diffused, it is desirable to direct such effort toward the regions, forest types, and areas where it will be most effective. The problem is complicated by the fact that there are both national and regional or local viewpoints and that these sometimes conflict. It is impossible, of course, to make a specific selection of all areas for intensive forestry now. This will have to be worked out step by step very much in the manner indicated by the Wisconsin report. But there are certain criteria which may serve to guide the selection of areas in local and national programs:

---

[1] "Forest Land Use in Wisconsin." Report of the Comm. on Land Use and Forestry, Madison, Wis., April 1932.

(*a*) *Volume production.*—There is a tremendous range in the potential growth in different regions and on different sites within a region. On one piece of ground the mean annual increment may be 100 cubic feet per acre; on another, a tenth of that. Obviously, other things being equal, it will pay to put intensive forestry effort where the forest increment will be larger.

(*b*) *Value production.*—A thousand cubic feet of one species of wood may be worth much more than the same quantity of another species. An economic prognosis may indicate the kinds of woods most likely to be in demand in the future, nationally or locally, whether hardwoods or conifers, structural or finish lumber, or specialty woods. Quality of product as well as species must be considered, for where there is a definite prospect of attractive special markets for products of certain sizes or grades an effort should be made to produce material suitable for such markets. As an illustration, it has been estimated that in New England favorably situated northern white pine stands if carefully treated may yield stumpage valued at $400 or more per acre, while in untreated stands of the same sort stumpage might not be worth more than $150. In general, conditions will be especially favorable for intensive forestry on those areas where it is possible to grow the most valuable species and the most valuable types of products.

(*c*) *Accessibility to market.*—This bears directly upon the stumpage value of any forest property. A forest close to a large population of users or near centers of wood-using industries will produce a greater revenue and justify more intensive practice, other things being equal, than one remote from such centers. Likewise a forest on easily logged ground is more remunerative than one on difficult ground or one that has a high transportation charge to reach. In regions of scanty timber, the existence of a substantial local demand may make possible the most intensive practice in the nearest forests even though these be as much as 50 or 100 miles distant and of relatively low quality and productive capacity. For example, possibly the greatest intensity of management and the closest approach to full utilization of the growth of the land anywhere on the national forests may be found in the artificial forests of the sand hills of Nebraska or in the stands of small-size lodgepole pine on the Minidoka National Forest in Idaho.

(*d*) *Risk.*—Because of differences in climatic conditions and to a lesser extent in the effectiveness of protection organization, forests of various regions and of various types differ widely as to likelihood of destruction by fire. Certain forest types and species are less subject than others to attack by known insect enemies and diseases. This will be an important consideration in making any investment for intensive forestry. From this standpoint natural conditions such as those which exist throughout most of Vermont and other portions of northern New England are perhaps ideal.

These four factors—volume production, value production, accessibility to market, and risk—all affect returns. On the other side of the ledger must be set down the cost of intensive forestry measures. Some forest types are easier and cheaper to regenerate than others.

Some require weedings, or insect and disease control; others do not. Planting costs vary greatly from region to region and from site to site. The cost of starting a new crop after logging mature timber varies all the way from practically nothing to perhaps $20 an acre. Some lands stocked with immature timber require practically no care, except fire prevention, to get full production, while others need treatments that cost several cents an acre a year.

In framing detailed programs and policies for the inauguration of intensive forestry practices, as Wisconsin is doing, the above factors of returns and costs should be carefully weighed, so that effort will be directed most effectively.

The principle of concentrating intensive forestry on areas of highest potential production cannot be applied from a national point of view solely; to do so would be to neglect the needs of communities in various sections whose welfare is intimately associated with successful management of local forests. State forestry programs are going to be carried out with thought of State needs. Private forestry programs are going to vary in intensity according to the individual attitude and financial set-up of the owner.

From many angles it would be ideal for each geographic division of the United States to produce the timber products that it needs to support its own domestic and industrial uses, but this is wholly impracticable. Some regions have not the acreage of forest land to do so; some regions grow one class of products (like hardwoods or extra-large timber) that other regions cannot grow; few if any regions can grow all the variety of products they require. There is now much shipment of products from one region to another, and apparently this must continue. The regions of highest potential production, or rather those with the greatest capacity for increased production, are not those closest to the country's major markets. The South and the Pacific coast, for example, are perhaps better suited to timber production than any other regions, and it will be economical for them to continue to export wood to other regions. However, other things being equal, it is desirable to grow forest products as close to where they are going to be used as possible.

The first consideration in instituting forest management on a forest property is to assure effective protection and the stopping of devastation on the whole property, and then provide the means for intensive forestry wherever on that particular property intensive forestry gives promise of being most profitable. Land classification, economic studies, and silvicultural studies will show what areas are best suited for intensive forestry, and the management plan for the property should be drawn accordingly—preferably prescribing a program for a tree generation.

OPPORTUNITIES FOR INTENSIVE FORESTRY IN CERTAIN FOREST REGIONS

As a supplement to the generalized discussion in the preceding pages of the principles, the necessity, and the objectives of intensive forestry, consideration will be given in summarized form to the opportunities for intensive practice in certain of the principal forest regions of the country. Here as before it must be remembered that attention is given only to those measures needed to step up volume and quality production which are supplementary to the planting of barren areas and to measures needed to stop devastation and to protect against fire, insect enemies, and disease.

NEW ENGLAND AND MIDDLE ATLANTIC STATES

In the Northeastern States from Maine to Maryland the need for intensive forestry is very clear. The average annual consumption of lumber is six times the local cut of lumber, and the consumption of pulpwood exceeds the cut by more than half. Judged on the basis of current growth the situation is even worse, since total drain on the forests of these States is one and one half times the growth. Of the softwoods alone the saw-timber requirements are almost six times the saw-timber cut, the deficit now being made up largely by import from the Pacific coast and the South. Before local forest supplies can be greatly increased by intensive forestry, cheap Pacific-coast lumber will probably have become less readily available. This points to the great desirability of increasing local production in this region against the day of need. Existing industries like coal mining and paper manufacture are dependent upon a perpetual cheap supply of special classes of forest products. Most of the region is accessible to markets, and it is felt that, even if most of the forests in the region were under intensive management, there would be little likelihood of oversupplying local demands.

A considerable portion of the commercial forest area in this region could advantageously be put under intensive forest management. Because of the dense population of the region, it may be anticipated that large areas of productive forest land suitable for such management will be withdrawn from commercial use for recreational purposes. Altogether it seems probable that from 11 to 15 million acres, including much of the former agricultural land which is being or may be planted, should eventually be under intensive forestry. Perhaps half this total would be in softwood production.

In the Northeastern States the northern white pine region presents the best prospects for intensive forestry. Topography is favorable, labor is abundant, potential markets are close at hand, and the principal species reproduce well, make rapid growth, and are easily managed.

In the white pine forests intensive measures will include releasing young pine from competition of gray birch and other species of little or no value, judicious thinning to maintain rapid rate of growth, selective pruning of the most promising trees, special salvaging operations in stands which have been heavily infested with the white-pine weevil, selective cutting of the mature timber whenever natural reproduction can be depended upon, and clear cutting and planting when it cannot.

The loblolly pine forests of Maryland present a situation similar in many ways to that in the northern white pine belt, and here intensive measures will follow the same lines.

Second only to these pine forests in prospects for intensive forestry is the oak-chestnut-yellow poplar type. The need for intensive treatment is emphasized by the serious depletion and deterioration of the growing stock at present, but this condition makes intensive management more difficult of application because of the scarcity of marketable material other than fuel wood. Weeding operations to favor the more valuable species in young stands will perhaps yield greater returns than any other cultural operation in this region. In stands of cordwood size improvement cuttings to stimulate the growth of the better trees and utilize the defective are needed over large areas. Selective cutting of mature stands, aiming to carry a gradually decreasing number of the best trees to large size, will almost universally prove desirable practice.

In the second-growth forests of northern hardwoods in the Northeast intensive measures similar to those outlined for the oak-chestnut-yellow poplar type are in order.

The large pulp and paper industries of the Northeast offer a ready market for softwoods and to a lesser extent for poplar and aspen in the spruce-fir-northern hardwoods region. These industries are now importing more raw material than they are obtaining from the local forests. Intensive production on the more accessible areas close to the mills should, therefore, prove highly desirable. To meet the needs for pulpwood the major effort should be to maintain or increase the proportion of softwoods in the mixed stands. Over much of this region no market exists for hardwoods, and in old-growth stands the hardwoods are found to be exceedingly defective, especially on areas from which the softwoods have been culled. Intensive treatment of these stands would include selective girdling of worthless hardwoods several years in advance of removal of softwoods, another girdling of hardwoods after the cutting of softwoods, and weeding of young stands to favor spruce and fir on clear-cut areas 5 to 7 years after cutting. Early and frequent light cuttings after the trees begin to reach merchantable size are desirable in order to utilize the balsam fir before heart rot sets in and to stimulate the growth of the residual stand.

The success of the measures suggested above is strikingly demonstrated on such areas as the Bates College Forest in Maine, the Yale Forest in New Hampshire, the Harvard Forest in Massachusetts, and the Eli Whitney Forest in Connecticut. The Harvard Forest of 2,100 acres of mixed pine, hemlock, and hardwoods in the 23 years during which it has been under management has had an increase of growing stock from an average of about 4,750 board feet per acre to 5,700 board feet. Yet in this period there has been cut an average of about 103 board feet per acre per year, which totals 2,380 board feet for every acre on the forest or one half the total stand when management was established. The annual growth per acre per year, estimated at about 120 board feet (17.1 cubic feet) in 1908, has increased to about 190 board feet (28.6 cubic feet). Annual growth is still far below the ultimate productive capacity of the forest, owing in part to the fact that none of the open lands which have had to be planted has begun to yield merchantable timber. Gross revenue has ranged from $4.76 to $7.15 per acre per year and net income from $0.50 to $1 per acre per year until the present depression. A permanent crew of five men has been employed, and twice that number has been used each year for part-time work.[2]

Similarly the stand on the Yale Forest, which is very largely northern white pine, increased from 2,370 board feet per acre to about 5,800 board feet in the 10-year period 1921–30, although on the average 81 board feet of sawlogs and 0.2 cord of fuelwood per acre was cut each year during this period. The average annual growth was about 75 cubic feet per acre.

---

[2] Fisher, R. T. The Harvard Forest as a Demonstration Tract. Quarterly Journal of Forestry 25:130-139. 1931.

On the Bates Forest of about 11,300 acres the growing stock, chiefly northern white pine, has been built up during the first 10 years of intensive management from an average of only 1,020 board feet per acre to 2,450 board feet. During this decade the annual cut has averaged about 646,000 board feet of logs and almost 1,200 cords of fuel wood, bringing a cash return of about $1 per acre per year.

Of the many specific examples of the application of intensive forestry that might be cited from all parts of the region, a few are as follows:

In 1877 a Connecticut farmer purchased a 26-acre tract covered with a young stand of hardwoods, mostly oak, which presumably had followed a clear cutting about 1850. At the time of purchase none of the trees were large enough for ties. Since that time the owner has obtained from this tract all the fuel wood used on the farm and also timber and lumber for repairing farm buildings and for rebuilding the barn. Besides more than 400 cords of fuel wood and some small orders for piling, more than 50,000 board feet of lumber has been cut from the tract. Yet the present stand totals more than 11,000 board feet per acre of sawlogs, with perhaps 10 cords per acre of fuel wood available in the tops and limbs.

The tract now contains one of the finest stands of hardwoods in Connecticut, the larger trees ranging from 18 to 30 inches in diameter. Cutting has always been on a selective basis, removing as logs only trees which had gained sufficient size to yield a good-quality product and taking cordwood from windfalls, defective trees, and tops of sawlog trees. It is evident not only that this tract has been an asset of real value, but that its contribution to the needs of the owner has been made from year to year without any lowering of its prospective yield.

On a State forest in New Jersey 26 acres of dense, thrifty white cedar stands, 30 to 45 years old, were thinned during a period of 3 years. All the suppressed, intermediate, and codominant trees were taken out; only sufficient trees to form a full stand at maturity were left. The products sold for $337 per acre, bringing a net profit of $37 per acre. At the time of cutting the value of the remaining standing timber was approximately equal to the gross value of the products removed. The trees removed would naturally have died before the stand matured, and the trees left are stimulated to more rapid growth which will probably shorten the economic rotation period.

Another example of profitable silviculture is taken from loblolly pine in Maryland. On an area of several acres of thrifty 14-year-old loblolly pine containing on the average acre 1,810 trees 2 inches or more in diameter, 70 percent of the intermediates and a few dominant trees, averaging in all 792 trees per acre, were cut in a thinning. Eleven standard cords of wood were obtained, and 15.5 cords were left standing. The 11 cords were sold at $5.50 per cord or $60.50 per acre. A net profit of $1.05 per cord or $11.55 per acre was realized. An average of 1,057 trees per acre were left standing, more than three times as many as natural stands contain at an age of 35–40 years, which will permit sawtimber operation.

LAKE STATES

In the States of Michigan, Wisconsin, and Minnesota there are more than 55 million acres of commercial forest land, but of this only 2,664,000 acres is occupied by old-growth saw timber. The remainder is cut-over land—cordwood stands, restocking and nonrestocking, and farm woodlands. The present yield from this grest forest acreage is very small, but has potentialities of being greatly increased.

It appears that in this region of badly devastated and deteriorated lands with fair potential productivity and with easy access to the great markets of the Middle West, the expansion of intensive forestry will be largely through public acquisition and management. The best lands are most likely to be used for intensive forestry. For the present, management of these areas will consist largely of planting and of controlling fires, insects, and disease. The great areas of low-grade poplar and fire cherry offer a most fruitful field for intensive forestry through converting them into more valuable pine woods. Where inferior oaks are keeping out better species, cultural cutting is needed at intervals. On the hardwood lands with a variety of species of different intrinsic value, cuttings are needed to let the better species through to the canopy. On spruce lands an effort to increase a market for Christmas trees would make thinnings economically profitable and these would stimulate growth on the remaining trees.

As has been stated earlier, Wisconsin's Committee on Land Use and Forestry has recommended a very specific policy of concentrating its initial forestry effort, other than widespread fire protection, on the most favorably situated 2 or 3 million acres. The two other States would do well to allocate a like area for intensive forestry. Reforestation of the huge area of devasted forest land in this region is already under way. Most areas brought into production in this way will probably be given intensive treatment. Eventually it seems likely that at least 11 and perhaps 20 million acres in this region will be under intensive forestry.

CENTRAL STATES

In the Central States, including Ohio, Indiana, Illinois, Iowa, Kentucky, Tennessee, Missouri, and (in part) Arkansas, less than 5 percent of the present forest area is under any form of forest management and little of this is intensively managed. It is estimated that in the next few decades some 6 to 7 million acres of the area which should be acquired for public forests may be put under intensive management. In addition there may be some 4 million acres of farm woods that could be placed under intensive forestry, but to do this would require an aggressive educational campaign.

On the Ozark Plateau of Missouri and Arkansas are some large timberland holdings a million or so acres of which may be economically ready for intensive forestry under private ownership within the next two decades. Fire protection is the essential first step. In Ohio, Indiana, Illinois, Kentucky, and Tennessee are timberlands of coal and other companies where markets are at hand and the physical conditions are favorable for profitable timber production; perhaps a million acres in this category ought to be under intensive forest management. The relatively large area of abandoned farm land and denuded forest land in need of planting in this region will eventually contribute materially to the total area under intensive forestry. Altogether, intensive forestry may perhaps be extended to 10 or 15 million acres in this region.

In the hill forests of the region cuttings should be made to release the high-value species black walnut, black cherry, ash, and yellow poplar so that they will be more abundant in the next crop and grow to large size; white oak, red oak, and hickory are other valuable species that should be encouraged in these forests.

An excellent opportunity for intensive forestry is offered by the farm woods of this region, which may be considerably augmented by tree planting, already begun on a small scale. Most woodlands lack adequate growing stock and require an increase in the number trees per acre. This increase can be obtained only by eliminating pasturing in the woods, which may be expected to lead to successful natural reproduction. If natural seeding fails, planting will be necessary. It is essential to the rehabilitation of these woods that cutting be postponed until the woods are better stocked.

Striking illustrations can be cited of the incomes which can be derived from well-stocked woods intelligently cut on a selection system. The Mennonites of northern Indiana and northwestern Ohio, coming to this country from Switzerland with a background of familiarity with forestry practices, have consistently practiced conservative selective cutting on their woodlands. One of these Mennonites has received in cash over a 13-year period a total of $10,457.73 for the products cut from 75 acres of woodland. This represents a gross return of $10.73 per acre per year. Since no outside labor was employed and the work was done at times when the man and teams would otherwise have been idle, the returns per acre compare very favorably with the gross return of less than $19 per acre for all cereals grown in Indiana in 1929. In addition to the products sold, this farmer has obtained without cost the fuel, fence posts, and lumber needed on his own farm. Meanwhile the woodland remains in excellent condition. At present the tract is at least 90 percent stocked.

SOUTH

In the Appalachian, South Atlantic, Gulf, and Lower Mississippi States are several primary forest types which are favorable for intensive forestry, namely the longleaf-slash pine type, the shortleaf loblolly-hardwood type, the bottomland hardwood type, the oak-chestnut-yellow poplar type, and the oak-pine type. The first three are particularly favorable; they have high potential yields and are accessible to market, and full production can be realized at a reasonable expenditure. Present practices in general are far from satisfactory, and the opportunities are wide open for stepping up production. It appears that much of the increased production necessary to balance the Nation's timber budget might be attained the adoption of intensive practices on the best land in this region.

It is estimated that between 18 and 19 million acres of the longleaf-slash, shortleaf-loblolly-hardwood, and bottomland hardwood types alone should be put under intensive forestry in the next 20 years. Perhaps nearly 14 million additional acres in the oak-pine and oak-chestnut-yellow poplar types should be so managed. In this region, also, planting of denuded and abandoned land is likely to augment greatly the total area to be put under intensive forestry. The total may thus reach 40 million acres. This would be about 20 percent of the commercial forest area in the territory, which embraces parts or all of the following States: The Virginias, the Carolinas, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Oklahoma.

The land has such high potential production and is economically so well situated that much of it is suitable for intensive forest management under private ownership; but little of it is now so managed.

In the longleaf-slash pine type, the usual object of management will be the dual production of naval stores on a continuous basis and wood products to be harvested in intermediate and final cuttings. To attain normal stocking of each property for sustained yield it may be necessary to enlarge the tract by acquisition, to plant the nonforested portion, merely to make well-timed cuttings, or to combine these practices. The operations will consist of (1) thinning overstocked stands, whether planted or natural, getting as much turpentine as possible from the trees to be cut in the years just prior to removal, (2) turpentining the remaining stand by conservative methods, (3) protecting against fire and hogs, and (4) harvesting the worked-out trees and restocking the land either naturally or by planting. Prevention of uncontrolled fire is essential to full production. Such forestry on the better sites is expected to yield a net annual revenue of $3 to $5 an acre.

In this type thinning has three objects: First, production of high-quality wood for structural and other purposes; second, promotion of the maximum quantity growth of desired forest products; and third, production of naval stores. On many areas all purposes will be attained. Where wood quality is principally desired, the effort will be to obtain dense wood, or wood with a relatively uniform number of rings per inch, on trees of good form and height. Where naval stores production is the main object good management will dictate wide spacing to obtain rapid diameter growth and wide crowns, as such trees have a high gum yield. This latter plan is being followed to some extent on the Osceola National Forest, Fla.

In localities where hardwoods grow in mixture with the pines, it will be desirable to control the hardwoods so as to encourage a larger proportion of pine.

Although slash pine can and does become established on longleaf sites, it is not yet known whether it will persist through a rotation. In order to insure a permanent forest on such sites it may be best to encourage the longleaf in its early years. This may possibly mean the use of carefully controlled fires and the exclusion of hogs.

In the shortleaf-loblolly-hardwood type the management procedure, in addition to prevention of fire, will be (1) thinning and improvement cuttings to remove wolf hardwoods and break up overcrowded groups of small trees, and (2) selective cuttings at intervals of about 10 years, removing pine and oak down to a diameter limit of about 17 inches. Regeneration in the openings made in the overstory by the periodic cuttings should be effected by natural means, without resort to planting. A considerable proportion of the commercial timberland of this type is on farms where intensive forestry is encouraged by accessibility of markets, prevalence of good sites, and ease of management.

As the pines are usually more valuable than the hardwoods with which they are generally found, encouragement will be given the pines in the early stages in stands where their growth and development are unduly hindered by the hardwoods. This may take the form of pasturage or of weeding operations to liberate the pines and to prevent whipping of the tops. Some thinnings will be needed in loblolly stands to encourage rapid diameter and height growth.

In the piedmont country from Virginia to Alabama the prevailing type is the somewhat less productive oak-pine type, the greater part of which is included in farms. As a consequence of unregulated cutting and repeated fires, low-grade oaks have largely monopolized the ground at the expense of the more valuable shortleaf and loblolly pine. Pine reproduction can be encouraged through weeding practices which will stimulate the pine and enable it to keep ahead of the oak sprouts. As the southern pine beetle often damages the shortleaf pine in this type, it is desirable to maintain good growth on the pine by occasional light thinnings. This is especially desirable for the reason that often the shortleaf, if once suppressed, does not again rapidly build up its crown, tending to develop "watersprouts." Trees attacked by the beetle should be removed from the stand.

In those parts of the Tennessee Valley where a limestone formation is prevalent, the valuable red cedar should be encouraged. This can be done by heavily thinning the intermixed pines or oaks so as to give the cedar sufficient room for rapid growth.

With active extension and educational work much of this type might be brought under intensive forestry, because it is very accessible, local markets exist for its products, and it can be managed as a part of farm procedure. Intensive forest care is doubly necessary here because of serious erosion on cleared lands, some of which have become sparsely restocked.

The bottom-land hardwood type presents a difficult management problem. The many inferior species contained in the mixture are usually left in logging operations, with the result that they supplant the more valuable species in the next stand; these weed species and brush often choke back the desirable species. Weedings will therefore be necessary to encourage the desirable species and permit them to form a full stand. Vines, which climb through the tops of very young trees and cause them to break or to become deformed, should be controlled. Desirable conifers such as cypress and cedar may be encouraged through heavy thinnings. Where fires occur in the bottom land it will be necessary to remove the damaged stems, which are likely to be rendered unmerchantable by rot, in order to free the ground for new growth.

Other measures called for, in addition to fire prevention, are (1) avoiding concentrated grazing; (2) removing culls, unmerchantable species, etc., as part of the main cut; and (3) on areas where it is yet possible, making a selective cut every 10 to 20 years to harvest the merchantable trees, mainly those 24 inches or more in diameter, and pole-size trees that for silvicultural reasons should be removed. In the harvesting operation it is desirable to effect a balanced utilization of all species of trees and classes of products, instead of culling the forest for a certain product only.

In the oak-chestnut-yellow poplar type of the Appalachian Mountain country intensive forestry under private ownership seems less practicable than in the types mentioned above, because of rough topography, slow growth, and scattered distribution of the good sites. However, over the limited range of soils where yellow poplar occurs the stands including this species are of outstanding productive capacity and value. Perpetuation of the furniture industry, which depends on this type for much raw material, is another incentive for practicing intensive forestry. But a much-expanded policy of public acquisition seems to be prerequisite to the practice of intensive forestry on any great area in this type. This is perhaps less true in West Virginia, where extensive forest stands containing much black cherry and a large area of farm woods may lend themselves to intensive management. In this type as elsewhere, the areas allocated for intensive forestry should be selected on the basis of good stocking, good site, and accessibility.

NORTHERN ROCKY MOUNTAINS

In the northern Rocky Mountains, particularly in the western larch-western white pine types, the immediate great problem is to stop devastation. In northern Idaho and Montana there is less than 8 million acres of private forest land to more than 22 million acres of national forest; but the private land is made up almost entirely of valleys, benches, and foothills with moderate slopes and good soil, while the national forest lands lie higher on the mountains, on steeper and less productive sites. On both classes of land extensive forestry methods are usually the most that can be put into practice, although the Forest Service has invested from $20 to $50 an acre on some areas in disposing of overmature hemlock, cedar, and white fir to build up the productivity of the site.

In northern Idaho, the average acre of private commercial timber is now about five times as valuable as the average acre of national-forest timber in the commercial timber zone. This may be taken as in some degree an index of the relative value of land in the two ownership classes for intensive forestry. Intensification of forest practice in this region should apparently be directed principally to the most productive lands, which at the present moment are mostly in private ownership although they are rapidly being abandoned as they are cut over. Except for one outstanding instance, intensive forestry has made no beginning under private control; public leadership is apparently necessary.

SOUTHERN ROCKY MOUNTAINS

The ponderosa pine, lodgepole pine, and spruce-fir forests of Rocky Mountains and adjoining plateaus are not highly productive, in general, nor are they very asccessible to national markets. Their greatest value is in satisfying local timber needs, furnishing a reserve for possible future national needs, and, what is perhaps equally important, serving various noncommodity uses such as recreation, grazing, or watershed protection. A large part of the forest acreage is in public ownership and under sustained yield management, but little intensive forestry is possible.

Where there is a ready market in farming communities, as in the ponderosa pine forests of the Black Hills of South Dakota, the planted forests of the sand hills of Nebraska, or the lodgepole pine forest in several localities in the Intermountain Region, notably in the Minidoka National Forest in southern Idaho, silvicultural practices are gauged to give intensive utilization and high productivity for the sites involved. In a few localities it has been possible to cut Christmas trees as a thinning operation.

PACIFIC COAST

In California the redwood type offers excellent opportunity for intensive forestry. Most of this type is in private ownership, is highly productive, and in any State program for increasing forest productivity merits early attention. Recent studies have indicated that selective logging can be practiced here both with profit to the owner and with assured prospects of continued productivity. If clear cutting is practiced provision must be made either for leaving adequate redwood seed trees or for planting up the vacant spaces between the sprouting redwood stumps. Without either of these measures, only a fraction of the potential yield will be realized. Before the depression a beginning was made by some operators in interplanting clear-cut areas with redwood.

In this region also there is great need for improving utilization, through the integration of industries and the manufacture of by-products, in order that the present great waste in lumbering may be avoided. Thinning of redwood sprouts and pole stands, and far better fire control, must also be part of the program.

In the sugar pine-ponderosa pine type the bulk of the commercial timber area is on national forests. It is being cut on a small scale in such a way as to assure continuous, though certainly not maximum, production. Integration of industries and availability of markers are not such as to permit complete utilization. The ravages of insects and fire are not adequately controlled. Much ground is occupied by low-grade or worthless white fir trees, which ought to make room for trees of better species. The opportunity for intensive forestry is obvious. On private land the great need is to stop devastation. This can be done by logging selectively and by taking more care to spare the advance reproduction. More intensive forestry is most likely to come about through increased public ownership.

An interesting example of intensive forestry practice may be observed on the Eldorado National Forest, Calif. Here dense 20- to 60-year-old thickets of white fir and California red fir were thinned for Christmas trees on areas accessible to roads. The operation netted a material profit and the forest was left in a much better condition for rapid growth.

The Douglas-fir type of western Washington and western Oregon offers excellent opportunity for intensive forestry, because the productivity of the better lands is high and can be maintained at not unreasonable cost. Here as elsewhere in the West, private timber averages better in quality than national forest timber and therefore offers better prospects of profitable returns. The first great need in this region is to stop devastation on private lands by greatly improved protection against fire and by provision for regeneration through selective cutting and otherwise. Where the timber has not already been injured by destructive logging, it might be profitably handled by group selection cuttings instead of the system of clear cutting which is practiced on most existing operations. Still more intensive practice might be applied to areas accessible to pulp mills and farms. Here the small hemlock, spruce, and true fir may be thinned for pulpwood and the small cedars may be used for fence posts. Such intensive forestry practice requires a more flexible system of transportation than the usual expensive logging railroads, and is predicated on cheap permanent truck and tractor roads.

In the ponderosa-pine type and associated types of eastern California, Oregon, and Washington, as in the southern Rocky Mountain region, most of the area is in public ownership and is now receiving good management, although not much of it is under intensive forestry. Prevention of devastation, through selective cutting, wise slash disposal, and prevention of fire and insect epidemics, will assure reasonably good productivity. In contrast with conditions in the more productive and accessible regions, economic conditions in this type will probably not justify much intensive forestry for several decades.

SUMMARY

This section deals with the intensive management of forests for timber production. It discusses the various factors which constitute intensive forestry, without considering special adaptations of these practices or other measures which may be involved in intensive management of lands primarily of value for watershed protection, grazing, or recreational use. Intensive timber management aims to realize the nearest practical approach to the maximum productivity of the land and to produce material of large size or high quality.

Intensive forestry is perhaps primarily distinguished by the use of cultural measures such as weeding, girdling, thinning, and pruning to control the composition, increase the quantity, and improve the quality of forest growth. In the restoration of deteriorated forests and the most advantageous handling of mature forests, in several regions selective cutting is an important element of intensive forestry. "Selective cutting" applies to a variety of cutting practices, referring in some cases to the removal of only those portions of the stand which can be handled most profitably, in other cases to the removal of only those kinds or sizes of trees which yield a maximum profit, and in still other cases to the removal of defective or deformed trees or the least desirable species in order to permit the more desirable elements in the stand to grow to larger size and produce material of higher value.

Refraining from cutting young stands until the trees have reached a size to yield maximum profit, and refraining from cutting mature stands under economic conditions which do not permit effective utilization, also constitute an element of intensive forestry. This is especially important in that realization of the ultimate productive capacity of the land requires that an adequate growing stock of usable timber be maintained in each forest.

Forest planting is an important element of intensive forestry, since it is often needed to restore denuded lands or abandoned agricultural lands to timber production. As an adjunct to various methods of cutting, forest planting may be desirable also for the purpose of maintaining complete stocking or modifying the composition of existing forests.

Intensive forestry presupposes an adequate system of protecting the forest from fire, insects, and disease. It must include protection from injuries which may result from overgrazing by livestock or from activities of deer, rabbits, porcupines, mice,etc.

Intensive forestry involves reasonably complete utilization of the forest growth. Waste may be avoided in some forest types by selective logging, in others by intensive marketing methods and by integration of wood-using industries. Research in utilization technique and in marketing practices should be of great assitance in reducing waste.

Finally, intensive forestry requires the development of a permanent system of roads serving all parts of the forest. Cultural operations, selective cutting, adequate protection, and close utilization are largely dependent upon the existence of an adequate transportation system. A suitable plan for permanent road development may completely change the financial aspects of logging and forest management.

Intensive forestry is shown to be needed for the production of the high-quality material required for special uses and also as a means of building up growing stocks, especially in the forests of the East, so that the timber growth may be sufficient in quantity to meet the probable future demands of the Nation.

Intensive forestry is of interest to the public largely as a means of meeting the national forest-products requirements in respect both to quantity and to quality. Private owners will undertake intensive forestry as a means of increasing and stabilizing the income from their forest properties.

It is estimated that the area under intensive forestry should be expanded at a rate of about 1 or 1½ million acres per year until a total of from 70 to 100 million acres is so managed. This should represent a reasonable balance among different types of forest management.

The areas placed under intensive forestry should as far as possible be concentrated in units favorably situated as to growing conditions and as to markets. The best areas available should be handled first, as they will yield the highest return on the investment involved. The possibilities for volume production and value production, accessibility of markets, the cost of the required measures, and the risk of damage by fire, insects, and disease will largely govern the selection of areas. The selection of areas for intensive forestry must be considered from a local and regional as well as a national viewpoint in order that the social and economic benefits of permanent wood-using industries may be well distributed.

Conditions, with respect to the possibilities for intensive forestry are discussed for seven different forest regions. The New England and Middle Atlantic States are shown to be favorable for intensive forestry because of density of population and concentration of markets. In the Lake States the need for intensive forestry is great because of the large areas of devastated land and low-grade forest.

The situation in the Central States invites the application of intensive forestry because of the large area of abandoned farm land, denuded forest land, and woodland seriously deteriorated by overgrazing, and the favorable conditions for the growing of valuable hardwoods. The South presents a wonderful opportunity for intensive forestry because of the large area of land available, the character of the forest, and the unexcelled growing conditions. Through intensive forestry the South may continue to supply a very large portion of the Nation's timber requirements.

West of the Great Plains the opportunities for intensive forestry are not so general as in most of the eastern territory. In the Douglas fir and redwood regions of the Pacific coast and to a lesser extent in the ponderosa pine and western white pine regions, considerable areas present conditions favorable for intensive forestry. But in most of the other forest types of the West poor quality of timber, poor growing conditions, rough topography, and inaccessibility of markets preclude the application of intensive forestry for timber production on any large scale. Intensive management may, however, be justified for watershed protection, grazing, or recreational use on some of these less favored western forests.

To bring about the application of intensive forestry on the scale indicated as necessary in the national forestry program will require public action in a number of ways. Public acquisition of forest land and demonstration of desirable practice will be important elements in this. Public aid and encouragement to private owners to place intensive forestry on the same plane with other industries will play an important part, also. The success of the various public measures in stimulating intensive forest management on private lands throughout the country will indicate, at least to some degree, whether or not public regulation of private operations is needed.

REFORESTATION OF BARREN AND UNPRODUCTIVE LAND

By Perkins Coville, Associate Silviculturist, and Lyle F. Watts, Director,
Northern Rocky Mountain Forest and Range Experiment Station

CONTENTS

Page
The extent of the problem—the barren and unproductive area 1485
Factors affecting the application of reforestation 1487
  Natural reforestation 1487
  Why planting should be done 1488
  Troublesome features to be overcome in planting 1493
  Accomplishments in forest planting 1496
The reforestation program 1498
  The initial step—a 20-year program 1500
  The division of responsibility 1506

THE EXTENT OF THE PROBLEM—THE BARREN AND, UNPRODUCTIVE AREA

In the United States today, as the result of logging, forest fires and the unwise selection and improper use of agricultural land, there are at least 135 million acres not long ago fertile and productive that are now denuded and unproductive. The idleness of this great acreage is not, however, its worst feature. Far more harmful in terms of public welfare is the capacity inherent in such lands for rapid deterioration or for causing damage to other lands and waters through erosion. As shown in the section "Current Forest Devastation and Deterioration", forest lands are being devastated at a rate close to 850,000 acres annually. Another section of this report, "Agricultural Land Available for Forestry", makes it clear that each year an average of more than 1½ million acres of worn-out agricultural lands, not more than half of which will revert to forest naturally, are being dropped from use. Continuation of this increase in acreage of idle and unproductive land will create a burden such as no nation can withstand indefinitely and continue prosperous.

Information obtained through the surveys upon which this report is based, supplemented by data on the agricultural land situation furnished by the Bureau of Agricultural Economics, gives some idea of the distribution and condition of this huge area of once productive land that through one cause or another now produces little or no return. Forest lands classified as nonstocked and poorly stocked constitute 83 million acres, of which 63 million will not produce a commercially valuable crop within a saw-timber generation. The abandonment or near abandonment of submarginal agricultural land contributes the other 55 million acres. Thus the period of exploitation and expansion from which we have recently emerged and which was based on the false premise that our natural resources of forest and soil were unlimited and indestructible, has created a situation which requires immediate attention. A part of the solution lies in the reclamation of such land through forest planting. No other practical measure will restore a large part of these lands to usefulness within a reasonable period. A few examples will indicate the character of some of the changes in the condition of land and the opportunities for reclamation through forestation.

There are some 5 million acres of abandoned farm land in the piedmont region of the South so badly eroded that, according to data from the Bureau of Chemistry and Soils, and State agencies, successful agriculture is impossible. The exposed subsoil is incapable of producing satisfactory yields of farm crops and is susceptible to further erosion, adding more detritus to stream channels and water supplies. It will, however, support tree growth and can eventually be successfully forested by planting. One million acres of the silt loam uplands of northern Mississippi is seriously and actively eroding, as disclosed by surveys by the Southern Forest Experiment Station. In the Central region 74 million acres (or 44 percent of the whole region) is eroding, some 10 million acres to a destructive degree, according to a summary of State soil surveys and other data gathered by the Central States Forest Experiment Station.

Roscommon County in the southern peninsula of Michigan, with an area of more than 300,000 acres, formerly bore splendid northern white pine timber that contributed its part to the one-time supremacy of Michigan in lumber output. A comprehensive survey by the State about 10 years ago showed that there was in this county less than 2,000 acres of land in actual cultivation. Much of the land is clearly devastated and the rest has but a scattering stand of low value species. The land that bore good stands of northern white pine is now in many cases incapable of growing a commercial stand of this species. The sandy soil through wind erosion and repeated fires has in many instances lost its fertility and must be rebuilt through rotations of jack pine or inferior species.

The people of New York State reached a decision in 1929 to reforest one million acres, of the 4 to 5 million acres of farm land that had been abandoned since 1880, a considerable part of which had not restocked naturally.

These examples do not by any means represent the whole of the problem but are indicative of a need for forestation so widespread as to be of primary national importance.

The area of land, including nonproductive forest land and permanently idle agricultural land, which is available for forestry is shown by regions in table 1. Much of this land will, however, restock to forest naturally within a reasonable period. A number of other factors to be discussed later will still further reduce the amount of this land which common sense would set up as the minimum for reclamation by planting.

TABLE 1.—*Estimates of present nonproductive land available for forestry, by regions*

Character of land	New England	Middle Atlantic	Lake	Central	South	Pacific	North Rocky Mountain	South Rocky Mountain	Total
	M acres	*M acres*	*M acres*	*M acres*	*M acres*	*M acres*	*M acres*	*M acres*	*M acres*
Nonrestocking abandoned land [1]	2,500	5,100	2,800	6,250	9,540	--------	--------	--------	26,190
Idle or fallow land [1]	158	1,377	898	3,493	4,848	--------	--------	--------	10,774
Pasture other than plowable or woodland [1]	1,078	2,384	2,314	4,602	4,362	--------	--------	--------	14,740
Total unstocked agricultural land	3,736	8,861	6,012	14,345	18,750	--------	--------	--------	51,704
Barren and unsatisfactorily stocked forest land [2]	2,425	3,329	13,755	5,188	43,555	9,672	3,666	1,709	83,299
Treeless prairie areas	--------	--------	200	1,450	250	450	250	400	3,000
Total nonproductive land available for forestry	6,161	12,190	19,967	20,983	62,555	10,122	3,916	2,109	138,003

[1] Data furnished by Bureau of Agricultural Economics, for forest counties east of Great Plains only. Nonrestocking and abandoned land here represented is the nonproductive portion of a total of 31,500,000 acres abandoned by 1930. Idle or fallow cropland and for pasture represent one half of the total amount of these classes of lands for 1930. The average rate of abandonment for the past 2 decades indicates the further abandonment of 15 million acres by 1940 and 30 million acres by 1950.

[2] Barren less than 10 percent, unsatisfactorily stocked 10 to 39 percent, of full stocking.

FACTORS AFFECTING THE APPLICATION OF FORESTATION

NATURAL REFORESTATION

Where adequate natural reforestation will take place in a reasonable time on areas now denuded or understocked there may be no need for planting. The extent of natural reforestation and the need will depend upon circumstances.

Critically eroded areas which might ultimately restock naturally but where reforestation is not taking place rapidly enough to afford timely protection, should be planted. Erosion on critical areas is now going on at such an accentuated rate that immediate action is justified to stop the sluicing of soil into the stream channels. In such cases we cannot afford to wait for the forest to become established naturally. This is particularly true in the Piedmont region, in parts of the Ohio River drainage and on the lower Mississippi drainages.

Further, there is the question of what should be the gage of satisfactory reforestation. Scattered trees, together with herbaceous and brush cover, may furnish adequate temporary protection of the land. One quarter stocked areas of Douglas fir reproduction in the Northwest may produce half of a full crop at commercial maturity, but the timber will be of poor quality since wide spacing does not promote early natural pruning. Certainly those agencies operating on a sustained yield basis should, in such instances, carefully consider the advisability of partial planting to insure full crops. For the purposes of classifying natural regeneration, 40 percent of full stocking has been selected as a satisfactory minimum. This is applied without regard to species, types, or individual circumstances. Although such a minimum is not satisfactory from the timber-production standpoint, the presence of this much young growth on an area does give reasonable protection against erosion and, with fire protection, does remove the land from an unproductive status. It should be stated here that forest planting, because of its high initial cost, is the forest land manager's last resort. Lands which will restock naturally within a reasonable period should be permitted to do so, thus confining the expense of planting to those lands which otherwise would be idle for a longer period than can be justified.

An estimate by regions of the area that will satisfactorily restock naturally if properly protected from fire, insects, and disease is given in table 2. In 20 years approximately 47 million acres, and in 40 years approximately 68 millions acres of the 138 million acres of the present unproductive land shown in table 1 are expected to restock. There remain practically 91 million and 70 million acres which will not restock in 20 to 40 years respectively.

TABLE 2.—*Estimate of area that will restock naturally and satisfactorily*[1] *in 20 and 40 years by regions*

Region	Area that will restock naturally		Region	Area that will restock naturally	
	In 20 years	In 40 years		In 20 years	In 40 years
	Acres	*Acres*		*Acres*	*Acres*
New England	2, 400, 000	5, 250, 000	Pacific Coast	3, 550, 000	5, 200, 000
Middle Atlantic	1, 250, 000	2, 400, 000	North Rocky Mountains	800, 000	1, 000, 000
Lake	1, 000, 000	3, 000, 000	South Rocky Mountains	20, 000	100, 000
Central	2, 500, 000	5, 750, 000			
South	35, 000, 000	45, 000, 000	Total	46, 520, 000	67, 700, 000

[1] "Satisfactory" stocking is defined as 40 percent or more of full stocking.

WHY PLANTING SHOULD BE DONE

There are three principal reasons for attacking the unproductive land problem through the agency of forestation.

1. Influence of forested land on watershed protection.
2. Need for more extensive local timber production to meet future requirements and to stabilize wood-using industries.
3. Value of forestation in the solution of social and economic problems arising from unwise land use.

PLANTING FOR WATERSHED PROTECTION

The effectiveness of forest cover in watershed protection has been amply made evident by general observations and to a lesser extent by experimentation under controlled conditions. For a full discussion of the character and extent of run-off and erosion that menace two of our most essential resources, soil fertility and water supply, reference should be made to the section "Watershed and Related Forest Influences". The problem as here reviewed is one both of erosion control and stream-flow regulation.

EROSION AND ITS CONTROL

The establishment of a forest cover on eroding areas by reforestation is a comparatively simple and effective means of controlling erosion. Even as a remedy for the most severe type of erosion, known as "gullying," which exposes sterile subsoil and leaves steep banks that easily slough away, reforestation is surprisingly successful.

Gullies planted to black locust have become stabilized within a period of a few years following planting, and the use of this species for control purposes is becoming general in sections such as western Tennessee, where its success has been amply demonstrated.

Forest cover exerts its control over erosion in a number of ways. Litter, the organic cover of the soil in the forests, prevents packing of the surface such as occurs on bare ground exposed to the weather. It adds organic matter to the soil, keeping it porous and receptive to the percolation of moisture. This reduces surface run-off and retards the erosive action of such surface run-off as may occur.

The results from a group of experiments carried out by Lowdermilk in California illustrate the effectiveness in erosion control of a forest cover produced by planting and of brush cover. The destruction of cover by fire resulted in the removal of soil by erosion at the rate of 4 cubic yards per acre from bare plots in one rainy season, whereas mere traces of eroded material came from undisturbed plots. Studies of forest soils in tanks, wherein litter cover was left on some and burned from others, showed that, under both artificial and natural rains, erosion from the burned plots was as great as 2,300 times that from the unburned when torrential rains were applied to the areas.

In preliminary observations on erosion plots in northern Mississippi one quarter of the annual rainfall carried away eroded material at the rate of 109 pounds per acre from a plot in a 20-year-old black locust-osage orange plantation, whereas 38,000 to 44,000 pounds per acre came from plots on an abandoned field and on cultivated land.

Denuded or barren watersheds are not satisfactory as a source of urban water supplies. Denudation encourages excessive silting of reservoirs or storage basins. The city of Raleigh, N.C., provides a typical illustration. The city has a municipal water supply which in 1914 consisted of an artificial lake, 77 acres in extent, and a watershed of 5.8 square miles. In 1914, when the dam was built, the lake had a capacity of 160 million gallons. Subsequently a large portion of the north side of the watershed was deforested by an agency not under the control of the city, and the capacity of the reservoir had decreased by 1932, through silting, to 100 million gallons. Another reservoir above the first was constructed in 1923, 136 acres in extent and draining a watershed of 6.83 square miles. This watershed is largely wooded, and silting has been negligible. The impounded water is much clearer after periods of heavy rain than that in the lower lake, which takes on the decided yellow-brown color of silt. The inference is reasonably clear that increase of forest cover on the lower watershed by forestation would, within a short time, materially reduce silting.

Forestation measures to control erosion have widespread application. Large areas of eroded land not capable of producing other worth-while crops are suitable to forest growth and, once the forest is established, the erosion cure is permanent provided reasonable protection and management is given.

STREAM-FLOW REGULATION

The forestation of barren and unproductive watersheds can play a big part in securing regularity of stream flow. The desirability of such regulation, particularly to reduce peak flows or floods and to increase low-water flows, is discussed more fully in the section already referred to, "Watershed and Related Forest Influences". Successful forestation results in the development of conditions which are far more favorable to ground-water storage than the conditions which exist on denuded or on cultivated land.

The experiments of Lowdermilk previously cited show that denudation by fire on plots in California increased run-off to 15 or 20 times that of adjacent undisturbed areas. Studies by the Lake States Forest Experiment Station have shown that the average maximum run-off from slopes in Wisconsin is nearly 10 times as large from cornfields and fallow ground as from the forest. In northern Mississippi, experiments previously referred to under erosion showed that the plots in a planted forest had a run-off that was less than 5 percent of a 12-inch rainfall, whereas plots on an abandoned field and cultivated land showed a run-off that was 44 to 48 percent of the same precipitation.

The superior ability of forest areas to absorb precipitation over that of denuded areas is due partly to the litter cover and partly to the condition of the soil itself. Studies by Auten in the Central States have shown that field soils when planted to forest will increase their capacity to absorb water eightfold in 20 years.

Plantations, therefore, are effective not only in controlling erosion and permitting better percolation into the soil but actually, on abandoned fields, in causing the absorptive capacity of the surface soil layers to increase greatly.

INCREASE IN TIMBER PRODUCTION

The section of this report entitled "The Present and Potential Timber Resources" indicates that saw-timber and cordwood production must be increased by more than 7 billion cubic feet in order to meet requirements at the present rate. This increase will be furnished in part by better protection of existing forests from fire, insects, and disease; and in part by more intensive management of the forests. A part of this deficit should be met by increasing the area of productive forest land through the planting of devastated areas or nonstocked abandoned farm land, or both. All three means should be undertaken simultaneously.

It is only fair to state at the outset that private interests, unaided, have at present little assurance of direct financial profit from large-scale plantings on barren lands. When unsupported by other areas of land bearing merchantable or near merchantable timber such plantings, on reaching merchantability, may have built up such charges in the form of planting costs, taxes, protection, and interest that they not always resolve into a profitable business for the private owner. Individual analysis of each situation is necessary to determine the financial soundness of planting.

In contrast, many wood-using operators own productive forest properties whose yield is inadequate to supply the full amount of timber necessary for permanent capacity output. Forest planting on barren or poorly stocked parts of their properties will increase their timber production and may make them independent of outside supplies, round out their properties, and hence protect the investment in manufacturing plants and improvements. The enlarged plant output thus made possible may increase the profit from the whole property and its inherent value will therefore be increased. In such instances the cost of planting becomes a charge against the entire operation rather than against the individual areas planted. The cost is a capital investment that does not have to stand alone, but is justified by providing continuity and improvement to a going operation.

One lumber company in the South became convinced that reforestation of its unproductive land by planting would permit it to operate its sawmill and its pulp and paper mill on a permanent sustained-yield basis. This company to date has planted more than 28,000 acres. In the Northwest one company, to assist in building up a permanent, sustained output, has maintained a forest nursery with an annual capacity of 2 million trees and has planted 8,000 acres to date. In the redwood region of California redwood operators in the interests of permanent operation have planted more than 26,000 acres, using some 13 million trees, this planting being more for the purpose of improving the density of the natural restocking than to reforest completely denuded or barren areas. These few examples indicate the possibilities of commercial planting as a part of going operations where there is a desire to operate on a permanent basis.

Planting by private agencies to create stands independent of natural timber growth under favorable conditions has been profitable in the past and will continue to be so. When divorced from the financial support of natural forest growth, plantations established by private agencies, to be profitable, should be confined to the more fertile, productive, and accessible sites. Rapid growth on such selected areas and a ready market for small material removed in thinnings and for the main crop will largely remove the financial risk that may otherwise be present.

There is no question about the desirability of greatly increased forest planting on farms. The farm woodlands, because of their accessibility and the purposes they serve, can be far more intensively managed than the average forest properties. Land submarginal and not suited to agricultural crops constitutes a part of many farms. Experience has repeatedly shown the possibility of disposing of wood as a cash crop at times when other sources of farm income have been seriously curtailed. Planting stock in most States can be secured at cost through Federal and State cooperation. Much of the cost of planting can be charged to otherwise idle time. The home demand for the timber is ordinarily present just as soon as the trees reach fuelwood size. These conditions together with the fact that farm woodlands make up more than one fourth of our total commercial forest area, indicate very extensive opportunities for effective and profitable reforestation by farmers and other small property owners for the purpose of reviving and extending farm woodland areas.

AID IN THE SOLUTION OF SOCIAL AND ECONOMIC PROBLEMS

A discussion of the causes and probable social effects of wholesale agricultural and cut-over forest land abandonment and of widespread unemployment is outside the scope of this section of the report. It is pertinent, however, to point out the possibilities of forest planting as an aid in meeting the situation.

To the extent that present unemployment is due to technological causes, such as the replacement of man power by machines, the oversupply of labor is probably permanent. New opportunities will have to be found for this surplus labor or the present opportunities for labor will have to be further spread out by decreased working hours per person. This may mean the general adoption of the 5-day work week, the 6-hour day, or the staggering of employment periods. In any event, the solution seems to indicate more leisure time for people generally. If this is true, the present rapid increase in outdoor recreation is likely to be accentuated and provision to care for it must be made.

The present extent of recreational use can be partially gaged by the fact that the national forests were used by 30 million people and the national parks by 3 million people in 1931. The extent of use of more local forested areas can only be approximated. That hunting alone now draws more than 6 million people into the forest each year is indicated by the record of licenses sold.

The present problem is that of providing desirable recreational areas close to centers of population so that they can be enjoyed by people with only a few hours, or at most a week-end, at their disposal. The planting of denuded or abandoned land within easy reach of cities may supply this need and incidentally build up new business enterprises in order to meet the needs of these recreationists. The new forests established in localities where forest cover is scarce will create or improve game cover and game food and will increase the pleasure of those who prefer hunting as a means of recreation.

The extent to which forest planting can go in furnishing productive work for the unemployed depends largely on the size of the planting program under way. The fact that some time must lapse between seed collection and field planting and the fact that forest nursery management is a highly specialized kind of land use would seem to argue against extreme fluctuation in the program from year to year. Over 80 percent of the planting expenditure from seed collection through field planting is for unskilled labor. The substitution of useful work such as this instead of charity for the unemployed is of course very desirable.

Some answer to the civic problem presented by devastated forest land and submarginal agricultural land is badly needed. Many communities which were once prosperous because of agriculture or lumbering are now rapidly approaching bankruptcy. In New York State nearly 3 million acres of land has been abandoned in the past 10 years. Tax delinquency of marginal lands is everywhere common and promises to increase, yet the public improvements made during the period of exploitation remain to be maintained by fewer and fewer local taxpayers. As the amount of idle land increases the resources with which to meet current civic obligations decreases.

A part of the answer seems to be closely associated with forest planting. Land classification, including economic investigations, should be undertaken to determine the highest usefulness of the land. In many instances the solution will probably be complete depopulation of considerable areas through taking advantage of tax delinquency supplemented by public acquisition. The areas thus blocked up in public ownership should be converted to forests by planting where necessary in order to protect the watersheds, improve recreation possibilities, and produce a future crop of timber. Unnecessary roads, schools, and other public improvements can then be abandoned to reduce the per capita cost of government.

Forest planting has a part in this solution whether it be the planting of marginal land near cities primarily for recreational use or the more extreme action contemplated by public acquisition of large tracts of marginal land.

TROUBLESOME FEATURES TO BE OVERCOME IN PLANTING

LAND CLASSIFICATION

Land classification should be undertaken to obtain essential information as to abandoned or other land that is definitely submarginal, land that is eroding or is needed for protection, and land, now partly agricultural, which should be blocked up into forest units as previously discussed. Abandoned agricultural land contributes very largely to erosion problems and it frequently offers greater opportunities for profitable timber returns than do the poorer classes of forest lands. Although depreciated in fertility from an agricultural standpoint, abandoned agricultural land is normally more fertile than the average devastated forest site, and it is usually more accessible. For these reasons forestation measures on submarginal farm land should be considered on a par with those on forest land. Final decisions as to the land to plant must be reached through the medium of proper land classification or its equivalent.

THE TECHNICAL FEATURES OF PLANTING

Marked progress has been made in meeting the technical difficulties in forest planting but much remains to be learned through research and experience. One of the difficulties to be overcome in the planting of denuded forest land is the direct outgrowth of processes that brought about denudation.

Clear-cutting and clean burning of forested areas may bring about changes of the site so unfavorable to seedling survival, that it will be impossible directly to reestablish the original species.

Studies of clear-cut and clean-burned forest sites in the northern Rocky Mountains showed striking differences between conditions on these areas and those under natural timber, as indicated in table 3.

TABLE 3.—*Characteristics of clear-cut, clean-burned sites in the northern Rocky Mountains*

Characteristic	Natural forest	Clear-cut and clean-burn areas	Difference
Average maximum duff surface temperature, growing season (° F.)	75	122	47
Absolute maximum duff surface temperature (° F.)	85	148	63
Minimum duff moisture content, oven-dry basis (percent)	17	4	13

The changes which result from cutting and burning are unfavorable to the growth of tree seedlings and may easily be fatal to them. Such maximum surface temperatures and drought-like conditions, though they exist but a short time, may make the difference between the success and failure of plantations on open sites.

The reforestation of sites that have been cut over, burned, and eroded will demand study. Many northern white pine sites in the Lake States, Engelmann spruce sites in the Rocky Mountain region, and others have been so changed that there is little hope of artificially restocking them at once with the original species. It may be necessary to restock the sites with less desirable but hardier species to produce forest-like conditions that will permit the reintroduction of the original species as a secondary step. For example, jack pine will grow on deteriorated northern white pine lands too poor to support white pine at present and can be planted to pave the way for a successful plantation of white pine in the future. It is of course obvious that what has been said applies also to the selection of species to be planted on cultivated or abandoned agricultural land. This land, however, usually has more favorable soil moisture and fertility than devastated forest land. Methods of analyzing sites to determine when the more desirable species can be successfully planted and when the use of the less desirable is a necessity, are needed for maximum success in any large reforestation program.

Heredity in trees has been largely ignored in this country. Tree seed has been accepted as satisfactory so long as it was of the desired species, fairly clean, and had good germinative capacity. No attention, generally, has been paid to the quality of the parent tree or to the climatic conditions where it was grown. In Europe "certified seed"—certified as to species, quality of parent tree, geographical and climatic source—is common. In this country two companies are known to have offered certified tree seed. The importance of seed source is recognized and amply justified when applied to other crop plants. According to records of the United States Department of Agriculture recognized agencies in 43 States reported, for 1931, 11,554,508 bushels, 8,851,723 pounds and 3,300 tons of seed of known ancestry and inherent characteristics. The amounts stated include the so-called improved, registered, and certified seed of the more common farm crops and are reported according to the established unit of measure for the crop in question.

Responsibility for agricultural seed-improvement work either rests with organizations variously called seed growers, or crop improvement associations, or with State experiment stations or State departments of agriculture. Funds for the work are raised by dues, inspection fees, sales taxes, appropriations where States take a hand, or a combination of these. The handling of certified tree seed might well be patterned along the same lines except that, due to the interstate character of the tree seed business, it would be necessary that registration of tree seed houses and inspection be centralized in the Federal Government, preferably in the Forest Service. The expense incident to such a service would be insignificant in comparison to the resultant values. A forest crop is long deferred and mistakes in source of seed, which can be avoided by proper certification and utilization of seed, may not be realized for many years after planting at which time corrective measures other than replanting are practically impossible.

The cost of this seed would be somewhat higher than the normal, but the extra cost is thoroughly justified and the practice of certification should not only be encouraged, but possibly be made obligatory, as in some European states, before intensive, widespread planting is undertaken. Experiments by the Lake States Forest Experiment Station have shown that seedlings of Norway pine from various geographical and climatic seed sources show marked differences in hardiness and early growth.

Many North American tree species have a wide geographical distribution and it is inevitable that unsatisfactory results will come, as they already have, from indiscriminate use of their seed. Ponderosa pine with a natural range of some 400,000 square miles of territory furnishes innumerable sources of seed. Experimental plantations of ponderosa pine from several seed sources, established in the Sand Hills of Nebraska, in Colorado, in the northern Rockies and at Wind River in southern Washington, show differences, some slight and intangible as yet, some marked, that leave little doubt as to the importance of seed source in forestation.

Much could be written on the past development of forest-nursery technique and the problems still to be worked out through research and practice. It should suffice in the present instance briefly to indicate the basis for confidence in future progress.

Nursery methods have been so developed that a consistent output of good quality stock at reasonable cost is now possible. Numerous factors contribute to these lowered costs, including favorable watering, fertilizer, and effective soil management practices. Damping-off, other diseases and chlorosis are rapidly being overcome. Better stock for a given purpose has been produced by obtaining proper densities in seed beds, root pruning, improved soil fertility, and by other means. As an illustration, the Savanac Nursery on the Cabinet National Forest now produces 2-year-old ponderosa pine seedlings at a total cost of about $3 per thousand trees.

Several examples of research findings may be given as an indication of the progress that can be made in solving those nursery problems that still confront the forester. Delayed germination of western white pine seed formerly handicapped nursery output by causing seed to germinate so late in the season that heavy mortality resulted due to heat killing during the summer, and produced seedlings of very uneven size at the time of transplanting. Experiments carried on at the Savenac Nursery (Montana) of the Forest Service have overcome this problem by demonstrating the feasibility of fall sowing of western white pine seed.

Many valuable species produce good crops of seed only at intervals of several years. Seed years in longleaf pine are usually so far apart, and the seed has deteriorated so rapidly under previous methods of storage, that there are periodic dearths of seed in all localities. If longleaf pine production in a nursery was to be sustained, this meant that it was often necessary to obtain seed from some distant point, with the attendant dangers of its being unsuited to the new locality. It has been found that longleaf pine seed if dried promptly after extraction and stored at a temperature between 34° and 40° F. will keep for 2 or 3 years, with no serious loss of vitality.

Much research needs to be carried on to insure the most economical and satisfactory production of nursery stock on a large scale but progress to date along this line is encouraging.

Planting methods have been the object of much experimentation. While cheap and successful methods have been worked out for some situations, the cost of planting is still high on many sites. It should be remembered that reduction in costs achieved at the expense of survival is not economy. There are definite opportunities however to pursue the cheaper, more expeditious methods of planting, and by research to determine means that will maintain or increase survival and at the same time favor optimum growth of the planted trees.

The examples mentioned serve to illustrate the types of problems which arise and the success to date in solving them. Experience coupled with the necessary research will anticipate or meet such situations in the future. It is exceedingly desirable that records be kept which will identify the stock used on each plantation as to source of seed, treatment in the nursery and at the time of planting. The technical supervision and research necessary to assure success of large scale forestation will represent a very reasonable charge, considering the expenditures and the great variety of conditions involved.

ACCOMPLISHMENTS IN FOREST PLANTING

ABROAD

Forest planting of idle and barren land is not a new venture in Europe, either as a means of soil stabilization or of timber production. One outstanding example of the creation of an extensive forest area from barren land is of particular interest.

In southwestern France there is a large area of sand dunes and marshes known as the Landes. Late in the eighteenth century, purely as a means of saving the area from the shifting sands, a program of afforestation was undertaken. The initial measures proved so successful that they were continued, and extended to marsh lands, and by the end of the nineteenth century over 1½ million acres has been planted to maritime pine. Today the Landes, once a worthless area of sand and swamp, is forested and one of the most productive areas in France. From it France gets the bulk of its naval stores and a large part of its construction lumber. The region was a vitally important source of timber for the Allies during the Great War.

The nations of central and southern Europe have used tree planting as a most important part of their effective work in controlling torrents and erosion in mountainous areas. In the Alps and Pyrenees alone close to half a million acres of land which, because of erosion, was once a menace to the limited and intensively utilized agricultural soils of the valleys, has been planted and stabilized.

IN THE UNITED STATES

The record in the United States is not insignificant. The best available records show that 1,892,000 acres have been planted to date. It is plain that in expanding our planting program now we are not starting out on a new untried venture. Table 4 shows by agencies the total acreage planted prior to and during the calendar year 1931.

TABLE 4.—*Forest planting in the United States prior to and during 1931*

Agency	Acreage planted			Number of agencies
	Prior to 1931	In 1931	Total	
	Acres	*Acres*	*Acres*	
U.S. Forest Service	296, 063	26, 765	[2] 322, 828	1
States	235, 957	61, 613	297, 570	[1] 109
Municipalities	56, 439	11, 553	67, 992	413
Industrial organizations	181, 814	20, 755	202, 569	291
Other organizations	18, 577	2, 156	20, 733	520
Schools and colleges	5, 768	1, 107	6, 875	313
Individuals	944, 027	29, 511	973, 538	16, 748
Total	1, 738, 645	153, 460	1, 892, 105	18, 395

[1] State forestry units and other State agencies—colleges, penitentiaries, reform schools, asylums, hospitals, etc.

[2] Includes about 90,000 acres of direct seeding. This method of reforestation was temporarily discontinued, because of unsatisfactory results, about 1912. It is now used only on an experimental basis.

It is interesting to note that of nearly 2 million acres planted to date only approximately one sixth each has been planted by the United States Forest Service and by State agencies, whereas the plantings by individuals amounts to one half. Planting by industrial organizations, which has already exceeded 200,000 acres, is a relatively new thing.

The total cost of planting, including all items from seed collections through field planting, has varied greatly by species, sites, and regions. Forest Service costs range all the way from $3 per acre for the more easily planted sites in the Lake States, where seedling stock is used and where the soil, free from rock and easily worked, lends itself to extremely rapid field work, to as much as $14 to $25 per acre on the more difficult sites in other regions. Plantations in the South which cost $5 to $8 per acre 10 years ago can now be established for as little as $3 per acre.

The degree to which planting has been successful as measured by tree survival is difficult to determine. Not many accurate data, except those collected upon United States Forest Service plantings, are available. It must be remembered, too, that the survival figures for the national forests shown in table 5, present primarily the results during the pioneering period. Planting was done on many areas on which it is now known planting was ill-advised. Species and kinds of stock subsequently shown to be unsuited to the region were used in some instances. Far from satisfactory as a future gage in planting, this record is nevertheless a remarkable accomplishment for a pioneer effort in the reforestation of predominantly poor sites.

TABLE 5.—*Acreage and survival of U.S. Forest Service plantings, through 1931*

Region	Area of successful plantations [1]		Region	Area of successful plantations [1]	
	Area	*Percent*		*Area*	*Percent*
New England	76	[2] 55	Pacific Coast	26, 574	71
Middle Atlantic	2, 526	99	North Rocky Mountain	33, 223	51
Lake	39, 960	[2] 51	South Rocky Mountain	21, 565	75
Central	13, 108	[2] 69			
South	798	[2] 50	Total and average	137, 830	61

[1] A plantation classed as successful must have 250 or more well-established trees per acre. Plantations normally checked through the fifth year.

[2] The severe drought of 1930 is to a considerable degree responsible for the low percentage of successful plantations in these regions.

Indicative of the success of the more recent plantings by the Forest Service are the following records: 555 acres of Douglas fir planted in 1920 on the Ranier National Forest in Washington with satisfactory survival on 98 percent of the areas in 1930; a large Englemann spruce and western white pine plantation set out on the Cabinet National Forest in Montana in 1928 with over 500 established trees per acre in 1931; a 33-acre Norway spruce plantation on the Monongahela National Forest in the East, with 98 per cent of the trees established after 4 years; 517 acres of white and Norway pine planted on the Chippewa National Forest in Minnesota in 1925, with 87 percent of the trees alive in 1931.

Although State plantings, like those of the Forest Service, are spotty, yet taken as a whole, they are sufficiently successful to warrant expansion. While no exact data are at hand, it is known that the State planting to date in both Pennsylvania and New York has been more than moderately successful in establishing plantations.

The record from two counties in New York State is illustrative of what may be expected from careful planting on reasonably suitable sites. In the spring of 1931, three quarters of a million trees were planted on 519 acres in one unit in Broome County. One year later the survival was 82 percent. Five blocks in Chenango County, including 3,806 acres, were planted in 1931, with a survival ranging from 85 to 88 percent in 1932. The plantings on these areas, having passed the crucial first year, should continue to develop satisfactorily.

Industrial planting, although limited in amount, has, as might be expected, often proved more successful than public planting. This has not always been a matter of better technique but frequently of better sites for planting. The industrials, largely lumber companies, have been planting the choice sections of their holdings which were originally selected because they were the best timber-growing lands. These companies have had little occasion to experiment with the forestation of the poorest types of land because, as a general thing, they have none or if they were so unfortunate they naturally have left them until last. The public agencies, on the other hand, had big areas of poor site land and perhaps wasted too much effort in trying to reforest these areas for watershed or other urgent public purposes instead of gradually approaching the problem through the knowledge to be gained from the more simple task of planting the best first.

Illustrative of the success of industrial planting is the company in the southern pine region with 28,000 acres of satisfactorily stocked plantations. Survival in these plantations has been very high, being more than 90 percent in most years.

THE REFORESTATION PROGRAM

Decision as to the acreage of barren and unproductive land which should be planted in the next 20 or 30 years must be based on (1) the necessity for meeting the requirements of the country for timber products and other intangible services including improved watershed conditions, (2) the social and economic desirability of putting all land to beneficial use.

The section of this report entitled "Timber Resources and Requirements," has shown the clear necessity for almost doubling the total cubic foot growth and increasing by five times the board-foot growth if future timber requirements are to be met. In order to do this the entire acreage of commercial timberland will have to be given adequate fire protection, losses from insects and diseases will have to be reduced, the acreage under intensive forest management will have to increase more than 1 million acres a year, and about 25 million acres will have to be planted in the next 20 or 30 years. The likelihood of meeting all of these objectives in full is remote. Certainly the full effects will not be felt before the end of the century. If by any chance the wood produced under this plan should exceed the national requirements the trends in world wood consumption indicate that such a surplus would be absorbed by the export market.

The extent to which reforestation is required to meet the most critical erosion and streamflow situations has been discussed in the section of this report entitled "Watershed and Related Forest Influences." The necessity for planting 10 or 11 million acres for this purpose alone has been shown. It should be stated that this includes only the most critical areas and in no sense indicates the area on which such action would be desirable. Fortunately most of the land which may be planted for watershed protection will, under proper management, be fully usable for timber production.

That idle land is an economic liability has been discussed in detail in the section of this report entitled "Is Forestry Justified" and elsewhere. Granting that this is true we have the problem of putting to work more than 70 million acres of land which will not in 40 years restock naturally (table 6).

TABLE 6.—*Estimate of unsatisfactorily stocked land available for forestry at various periods*

Region	Present unsatisfactorily stocked area available for forestry [1]	Area that will remain unsatisfactorily stocked	
		After 20 years	After 40 years
	Thousand acres	*Thousand acres*	*Thousand acres*
New England	6,161	3,760	910
Middle Atlantic	12,190	10,945	9,795
Lake	19,967	18,971	16,971
Central	20,983	18,488	15,238
South	62,555	27,555	17,555
Pacific Coast	10,122	6,572	4,922
North Rocky Mountain	3,916	3,116	2,916
South Rocky Mountain	2,109	2,089	2,009
Total	138,003	91,496	70,316

---

[1] See table 1.

In considering the extent to which reforestation of submarginal agricultural land is justified the fact that this land may again be needed by agriculture is too often overlooked. Present trends in the production of agricultural crops and in population indicate a need for maintaining or slightly increasing the present acreage in agriculture. The fact that some land now in agricultural use (estimated to be 20 or 25 million acres) will probably become submarginal makes the rehabilitation of this land very desirable. It may again be needed. Its future suitability for such use will depend on the degree to which its original productivity is restored. Idleness will not greatly increase soil fertility while use of the land for forestry, even though temporary, will build up the organic content and thus the fertility of the soil. That this is true has been demonstrated in many parts of the South and elsewhere.

While all of the unproductive land should ultimately be put to beneficial use, the acreage recommended for immediate utilization will be limited to that which will meet the timber requirements and will at the same time meet the present critical watershed situation. With the completion of the initial program, which follows, it will no doubt be desirable to continue the work on about the same scale until all of the land under discussion that has commercial timber-growing possibilities has been put to its highest use. To plant the 25 million acres in 20 or 30 years will tax the resources of all agencies concerned to the utmost.

THE INITIAL STEP—A 20-YEAR PROGRAM

The situation described in this and other sections of this report clearly calls for aggressive action in largely expanding the work under way in forest planting. The initiation of such an expanded program for the immediate future must, as stated previously, be based on the urgency of the work in each region and on the size of the area which should be reclaimed finally. With these facts in mind the program recommended in table 7 and illustrated in figure 1 has been built up. It is based on the best judgment of State Foresters, land economists, Federal forest officers, soils experts, and others who have knowledge of conditions in the different regions.

TABLE 7.—*A 20-year planting program—details of areas to be planted and probable costs, by regions*

Region	Area to be planted	Planting costs per acre		Total costs [2]
		Present range	Program average [1] [2]	
	Acres			
New England	500, 000	$12–$16	$10	$4, 537, 000
Middle Atlantic	3, 500, 000	8– 14	10	34, 267, 000
Lake	7, 500, 000	4– 8	5	30, 500, 000
Central	6, 000, 000	7– 12	8	41, 667, 000
South	5, 750, 000	3– 7	7	38, 350, 000
Pacific Coast	1, 075, 000	9– 12	10	8, 583, 000
North Rocky Mountain	600, 000	9– 12	10	5, 587, 000
South Rocky Mountain	600, 000	12– 20	15	8, 500, 000
Total or average	25, 525, 000		6. 70	171, 991, 000
Average per year	1, 276, 000			8, 599, 500

[1] The cost of trees and planting to public agencies only.

[2] Private planting costs lower than public planting due to Federal and State aid. For further details as to the derivation of these figures see table 8.

Along with the actual planting must go comprehensive land classification or an equivalent and land use planning to assist in the selection of those lands which should be permanently removed from agricultural use either because of their submarginal character or because of the probability that continued cultivation will destroy their value through erosion. Several States, including Wisconsin, New York, Michigan, and Illinois have already made substantial progress. This work should be speeded up. Areas whereon crop production is so low and where abandonment has gone so far that the maintenance of the necessary public improvements such as roads and schools can no longer be justified should be blocked up for public forests. The same action should be taken on critical erosion areas which cannot be handled satisfactorily in other than public ownership.

In the immediate future planting should largely be done on those areas on which success will be fairly certain, and where accessibility for the use of the product is high, or on which a forest cover is immediately essential to erosion control. Included under both of these classifications will be part of the abandoned farm land east of the Mississippi. As the work expands, successful ways and means will be found, through research and experience, to plant progressively more difficult areas at reasonable cost.

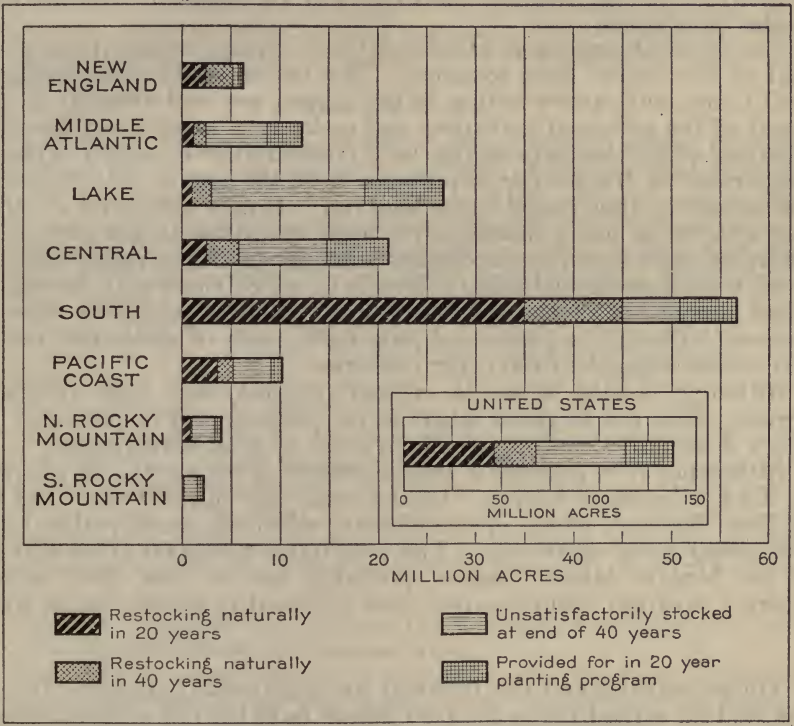

FIGURE 1.—Although natural restocking will reclaim for forest growth considerable portions of the present unproductive acreage, a substantial 20-year planting program will be essential in most regions to bring this vast area into a reasonable degree of productivity.

The immediate regional needs for forest planting are explained briefly in the following paragraphs.

REGIONAL JUSTIFICATION

NEW ENGLAND AND MIDDLE ATLANTIC REGIONS

The New England and Middle Atlantic regions constitute the most densely populated section of the United States. As a result of early settlement and improper management of agricultural areas, farm land abandonment is now in advanced stages and presents a serious problem. In New England much of the abandoned farm land has become restocked with forest growth, although often, and especially more recently, this has been of inferior quality. In New York and the southern portion of the region abandoned farm lands have not restocked so generally. The heavy demands of the dense population of these regions for potable water supplies justifies reforestation of some of the open land for the protection of watersheds. Large areas of forest land should also be provided to meet the recreational needs of the people in this section and this will call for planting of other portions of the open land.

Planting in the regions, however, will be primarily justified for timber production.

The New England and Middle Atlantic regions import more than half of the timber they consume. The better hardwoods, northern white pine, and spruce native to the region, are well adapted to the needs of the principal industries and make very satisfactory growth. Planting of idle lands to enable local communities to supply a larger proportion of the timber requirements of the region will probably prove sound public policy in the long run. It may also prove cheaper and quicker in many instances for local industries to get growth of desirable species on more accessible areas by planting, rather than to work with deteriorated natural forests in which there may be only a small proportion of the species desired. This is especially true in sections tributary to paper and pulp mills much of whose raw material is now imported from other countries.

Although erosion is not a critical problem over most of these regions, there are localities where forest planting will be necessary to check destructive erosion or reclaim areas of wind-blown sand.

Altogether it is estimated that 4,000,000 acres should be planted in the northeastern section. Of the total only 500,000 acres will be in New England, where open areas are relatively small and natural restocking more aggressive. The remaining 3,500,000 acres will be in the Middle Atlantic region, probably half in New York alone, where a program commensurate with the need is already under way.

LAKE REGION

Timber cutting and fire followed by unsuccessful attempts to use the land for agriculture in the Lake States have left idle a large acreage of highly productive timberland. Forest planting on a large scale on these northern white pine and spruce lands is justified for timber production alone. The region is close to heavy lumber consuming centers. It joins the Corn Belt where lumber importation is and will continue to be large. The industrial cities on the Lakes are large users of wood. Demand for small material for novelty, pattern, and shop work already exists and there is a large wood-pulp industry to maintain.

Transportation facilities are good. This includes water transportation on the Lakes which with the St. Lawrence waterway would permit of direct loading for export. There are ample rail connections to agricultural communities and inland cities. Road development has already made most of the timber section accessible to autotruck transportation.

The annual growth rate on fully stocked, average or better spruce and white pine lands is estimated to be 250 to 300 board feet per acre.

This rate, while slower than that of the southern pine and Pacific coast fir types, is quite satisfactory. This growth rate coupled with high quality product and intensive demand close at hand justifies the planting of 7½ million acres.

Planting for erosion control of an additional half-million acres is clearly desirable. This area is divided between the bluff lands of the upper Mississippi River and the sand-dune areas of the Lake region.

This program by no means reclaims for productive use all of the 27 million acres of idle land estimated to be available for forestry, and of which only a relatively small area will restock naturally in 40 years. After planting 7½ million acres of the best of this unstocked land there will remain approximately 15 million acres for future attention. Only the most urgent and most clearly justified plantations have been recommended.

CENTRAL REGION

The Central region, predominantly agricultural, is a large importer of lumber. Of the 14½ million board feet of lumber used annually only 1⅜ billion board feet are produced locally. Reliable data on fuel wood and farm timber consumption are lacking but they are large.

Deterioration of agricultural land fertility, through improper cropping methods and erosion has reached a point where a large acreage of farm land is now definitely submarginal. Not less than 10 million acres, according to State soil surveys, informed State officials, etc., have been so destructively eroded that permanent profitable agricultural use of them is impracticable. On upwards of 6 million acres of this land no practical means other than forest planting, supplemented in some instances by engineering works, will stop erosion. This condition accounts for the fact that the percentage of denuded land recommended for planting is higher in the Central States region than elsewhere. The other 24 million acres will in part be restocked naturally and a still larger part will be revegetated well enough with grass, weeds, and brush to stop erosion if eliminated from agricultural use.

The area recommended for planting, including that purely for farm woodlands, is 6 million acres.

While erosion control is the primary reason for planting, the timber produced promises to have a ready home market and will help to solve the regional problems of cheap low grade lumber.

SOUTH REGION

The commercial forest area in the South region is 190,758,000 acres, of which 43,555,000 acres, as the result of fire and mismanagement, are now barren or poorly stocked. An additional 19 million acres of submarginal agricultural land brings the total area of nonproductive land available for forestry to about 62½ million acres.

Natural restocking in the South takes place rapidly if seed trees are present and if reasonable fire protection is given. With this in mind, it is estimated that 45 million acres of this idle land will restock naturally within 40 years, most of it in 20 years. The remaining 17,555,000 acres will not reach a productive condition within a reasonable time without planting. The immediate planting (20-year program) of only 5,750,000 acres of this land is recommended, of which 1½ million acres should be planted purely to increase timber production on high quality pine land, upon which fire protection and other charges must be met because of their location within established operation boundaries. By planting these nonstocked lands the permanent annual output of the area can be increased at a slight per-acre cost when spread over the entire operation.

As shown in detail in the section entitled "Watershed and Related Forest Influences," erosion on denuded forest and on farm land in the South now creates a situation of major importance. Most of these eroded lands are included in the 17½ million acres of idle land which will not promptly be restocked. Within this classification are some 4 million acres of critically eroded land, on which forest planting is clearly the most logical method of control.

It should be stated that the present program does not contemplate the planting of any land on which erosion will be controlled by proper agricultural methods, or by simply dropping it from all sorts of use, unless its planting is also at least partly justified for timber production. The planting area recommended is the absolute minimum to properly meet the existing situation.

The erosion area which should be planted is divided between the piedmont plateau, the Appalachian Mountains, the upper coastal plains, the Mississippi River tributaries south of the Ohio River, and the Mississippi River bluff country.

PACIFIC COAST

The acreage to be planted during the next 20 years in the three Pacific coast States is largely for the purpose of increasing the possible sustained yield production in the different logging units' Erosion on timber lands can generally be prevented by complete fire protection, by improved logging methods, or by the adoption of sound range-management practices.

The area of available forest land now unproductive which will not restock in 40 years is estimated to be 4,922,000 acres. A large part of this is of poor site quality and is comparatively inaccessible. Planting of such lands is not advisable at present.

After careful consideration of all factors the planting of slightly more than 1 million acres of the better and more accessible lands is recommended. An additional small area of highly valuable watershed brush lands in southern California has been included.

The greater part of the commercial forest land planting will be located in the highly productive Douglas fir and redwood regions. The balance will be on once productive brush-land slopes of northern California and central Oregon. The need for planting in the brush-field areas is great, and when proper methods to secure success at reasonable costs have been worked out a much larger area than is contemplated now will be justified for planting. There is a distinct possibility that brush-field planting will help materially to reduce the fire menace which these brush fields now constitute.

NORTH ROCKY MOUNTAIN REGION

The necessity for immediate planting in the northern Rocky Mountain region is almost wholly for timber production. One of the leading industries of north Idaho and western Montana is lumbering. This industry is built up around western white pine because of its high value and former abundance. The fact that this species on average sites grows at the rate of about 400 board feet per acre per year fully justifies planting.

Nearly 4 million acres of the timberland is now poorly stocked or barren; however, it is estimated that by natural restocking this acreage will be reduced to about 3 million acres by 1970. Planting surveys of the poorly stocked land furnish the basis for recommending planting on only 600,000 acres at the present time. The area recommended includes only the better timber-producing land and largely only those areas which are now considered accessible from a lumbering standpoint.

SOUTH ROCKY MOUNTAIN REGION

The area of unproductive forest land in this region, which will not restock naturally in the next 20 years, is in excess of 2 million acres. A large part of this land has a present value as range for livestock and under proper management can be permanently used for this purpose. There is, however, a considerable area, mainly in Colorado, where erosion on denuded forest lands is extremely serious and where this condition can best be corrected by forest planting.

Timber growth rate is relatively slow, hence planting primarily for timber production should at present be restricted to those areas where planting is clearly justified to supply the future needs of nearby cities or intensively-used irrigation agricultural communities.

The area recommended for planting is that included in the present national-forest program plus the small additional areas which are clearly desirable for farm woodlots and for improvement of watershed conditions on other than federally owned land.

ESTIMATED COSTS

While the total cost to carry out the program recommended, as shown in table 6, seems large it must be remembered that the burden will be divided between many agencies. Farm woodlot owners, industrials, municipalities, counties, States, and the Federal Government will each share in the work. The cost to each agency as shown in table 8 will not be out of reason. It will be relatively small during the first few years and will probably not exceed a total of $12,000,000 per year at any time. The average expenditure per year will be less than $9,000,000 for all agencies during the 20-year period.

As compared to the reduction in flood damage and control cost, stream channel improvement costs, and the damage to the soil through erosion, which can be prevented by forest planting, the costs of the entire program seem small indeed. Costs chargeable to erosion, through reductions in engineering works will be in effect self-liquidating, and these and other areas planted will go far in aiding in a solution of the social problem which results from unwise land use and in meeting a future deficit in timber production.

PRESENT NATIONAL-FOREST PROGRAM

The present 20-year program of the Forest Service based on existing national-forest area rather than on the enlarged area which should result from future land acquisition is given in table 8. As land is acquired the acreage to be planted will have to be expanded to meet the needs of the land added. The estimated cost to complete the planting called for under the present Forest Service program will be approximately $21,000,000.

TABLE 8.—*Present national-forest program of area to be planted by 1950*

Region	Acres	Region	Acres
New England	400	Pacific Coast	260,000
Middle Atlantic	40,000	North Rocky Mountain	439,000
Lake	500,000	South Rocky Mountain	540,000
Central	215,000		
South	106,000	Total	2,100,400

SEED TESTING AND CERTIFICATION

Forest planting on the scale proposed and by many agencies both public and private must be protected against the use of seed of poor quality or unsuited to the locality where it is to be planted. While compulsory seed certification is not contemplated, those agencies desiring to use high quality seed should be able to look to some official source for insurance against misrepresentation. This service should be extended as a form of public aid and, for reasons previously given, should be centered in the Forest Service of the Federal Government. It is similar to the market inspection now made of farm products and annually provided for in the Agricultural Appropriation Act.

The service to be given should (1) provide an official seed laboratory in which seed would be tested for germination under controlled conditions and for purity, (2) provide, through the field forces of the Forest Service and cooperating agencies, for official registration of seed houses and certification of their seed as to species, elevation and geographic location of individual seed sources, and date of collection, (3) provide a central agency through which all imported tree seed for other than experimental planting must pass for certification.

The cost of such service will be very small and should be borne by the Federal Government as an incentive to increased reforestation. An appropriation of $50,000 per year will cover the cost of this service.

DIVISION OF RESPONSIBILITY

The division of responsibility for planting by ownership classes is greatly complicated by the existing ownership situation. Of the area in immediate need of planting (25,525,000 acres) only 2,100,000 acres are now in Federal ownership and probably not more than an equal amount is held by other public agencies. At least five sixths of the area is therefore in private ownership. The extent to which the ownership obstacle is overcome will determine in large measure the degree to which the recommended program is accomplished.

PRIVATE RESPONSIBILITY

Under existing conditions private effort in planting will depend entirely on self-interest which in most instances will be inseparably linked with early financial profits.

Farm-woodland planting is of course in a special classification. Here the justification for greatly enlarged effort is clear. Planting stock in most States can be secured at cost, the work of setting out the trees will usually be done during slack work periods with little actual cash outlay to the owner, submarginal areas on otherwise supermarginal farms are usually available, and the plantations will have early value in improving living conditions and in furnishing timber for farm use or for sale as a supplemental cash crop.

Industrial planting should be stimulated by public aid of one sort or another. Planting stock should be furnished at cost, advice in planting and subsequent management should be made available through enlarged extension service, seed-certification service should be provided for owners desiring to grow their own nursery stock, financial assistance in fire protection on a fair basis should be extended, and an equitable method of taxation of reforestation lands should be inaugurated in the several States.

With such assistance and advice private owners will be encouraged to extend the work being done in this field, particularly where the planting of unproductive areas coupled with the leaving of a better growing stock on cut-over lands will enable them to approach sustained yield in their operation. Although farm woodland and industrial planting might take care of 6 million of the 25 million acres during the ensuing 20-year period.

PUBLIC RESPONSIBILITY

Public responsibility, aside from the forms of aid indicated to stimulate private effort, had best be restricted to the planting of public lands. A large acquisition program, both Federal and State, seems inevitable in viewing the whole forest-land ownership situation. A substantial part of the land may be acquired through land abandonment and tax delinquency, a lesser amount through outright gift, and the balance through purchase or exchange. Part of the land acquired, because of the public importance of watershed protection, will be land in need of immediate planting. The actual division of responsibility between Federal, State, and local governments is contingent on such factors as the ability of the various units to finance a program as large as that to be undertaken, the extent to which watershed values are interstate in character and the degree to which reforestation will aid in the solution of local social problems.

In arriving at the actual division given in table 9, the acreage for farm woodland and other private planting was first determined from the best available data on ownership conditions and the possibility of permanent management of the land for timber production. The Federal program was next set up by starting with the 20-year program shown in table 8 and adding to it the planting which will be required by the acquisition program set up elsewhere in this report. The balance, for each region, was assigned to other public agencies including the States, counties, and municipalities. While the area assigned to the last group seems large when compared to that assigned to the Federal Government it must be remembered that this grouping includes 48 States besides a great number of counties and municipalities which are or should be responsible for carrying forward a part of the burden.

The public necessity for improving watershed conditions and stopping stream-channel silting requires the planting of much land now in private ownership. The alternative to private initiative stimulated by public aid is recourse to public regulation which with barren land might mean expropriation or merely another form of public acquisition. With all of these factors in mind the approximation of responsibility by broad ownership classes shown in table 9 seems logical. It makes no claim for accuracy but will be helpful in crystallizing in some degree the comparative parts of the program which each group of agencies should undertake. Comprehensive land classification or its equivalent must be greatly speeded up in order that a sound basis for the selection of specific areas to plant and for the determination of the most equitable division of responsibility may be had.

TABLE 9.—*Areas proposed to be planted by various agencies, and cash expenditures involved in planting*

Region	All Federal		All other public[1]		Farm woods[2]		Other private[3]		Total	
	Area[4]	Cost	Area	Cost	Area	Cost	Area	Cost[5]	Area	Cost
	Thousand acres	*Dollars*	*Thousand acres*	*Dollars*	*Thousand acres*	*Dollars*	*Thousand acres*	*Dollars*	*Thousand acres*	*Dollars*
New England	35	350, 000	350	3, 500, 000	50	167, 000	65	520, 000	500	4, 537, 000
Middle Atlantic	150	1, 500, 000	3, 100	31, 000, 000	50	167, 000	200	1, 600, 000	3, 500	34, 267, 000
Lake	2, 000	10, 000, 000	3, 000	15, 000, 000	1, 500	2, 500, 000	1, 000	3, 000, 000	7, 500	30, 500, 000
Central	1, 500	12, 000, 000	3, 000	24, 000, 000	1, 000	2, 667, 000	500	3, 000, 000	6, 000	41, 667, 000
South	1, 500	10, 500, 000	3, 500	24, 500, 000	150	350, 000	600	3, 000, 000	5, 750	38, 350, 000
Pacific Coast	450	4, 500, 000	125	1, 250, 000	250	833, 000	250	2, 000, 000	1, 075	8, 583, 000
North Rocky Mountain	500	5, 000, 000	10	100, 000	50	167, 000	40	320, 000	600	5, 587, 000
South Rocky Mountain	540	8, 100, 000	10	150, 000	50	250, 000	------	----------	600	8, 500, 000
Total	6, 675	51, 950, 000	13, 095	99, 500, 000	3, 100	7, 101, 000	2, 655	13, 440, 000	25, 525	171, 991, 000

[1] Including State, county, and municipal.

[2] Estimate based on assumption that farm planting will cost only one third as much per acre as planting by public agencies, owing to availability of stock at less than production cost and to use of regularly employed farm labor in slack seasons for planting.

[3] Including industrial planting by timber companies, power companies, etc.

[4] Including part of the land proposed for acquisition by 1950.

[5] Estimate based on assumption that cost to planters will be reduced $2 per acre by State and Federal aid.

A WATERSHED PROTECTION PROGRAM

By L. F. Watts, Director, Northern Rocky Mountain Forest and Range Experiment Station; E. N. Munns, Chief, Division of Silvics; W. R. Chapline, Chief, Division of Range Research; and Luther G. Schnur, Associate Silviculturist, Allegheny Forest Experiment Station

CONTENTS

Page
Influence of forest cover ---- 1509
Relation of ownership to watershed conditions ---- 1512
Major critical situations ---- 1521
Program for adequate watershed protection ---- 1532

INFLUENCE OF FOREST COVER

That stream flow and erosion are greatly influenced by the kind and condition of forest and other vegetative cover has been shown in the section of this report entitled "Watershed and Related Forest Influences", hereafter called the "watershed description section." Profound changes, it is evident, have taken and are taking place in the regimen of our streams, and undesirable soil movement has taken and is taking place on great areas of watershed land. These changes, usually harmful in their effect, have been shown to be largely the result of improper use of forest, range, and farm land.

The introduction to the watershed description section has shown that the degree of a forest's influence on watershed functioning depends on (1) the type and condition of the forest, (2) the characteristics of the soil, (3) the topography, and (4) the intensity and purpose of water use. A classification of the forest areas of the United States as to watershed-protective value, on the basis of these factors, is presented in table 1 and figure 1.

Almost three fourths of the total forest area has been classified as watershed-protection forest, that is, as having major or moderate influence on watershed values. The remaining fourth, because of flat topography or extremely permeable soil or for other reasons, is considered to have slight influence or none. Of the watershed-protection forest about two thirds, or 308 million acres, exerts a major influence and one third, or 141 million acres, exerts a moderate influence.

TABLE 1.—*Watershed-protective value of forests in the United States*

Drainage	Total land area	Total forest area	Forest area by watershed-protective influence		
			Major	Moderate	Slight or none
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
East:					
Northeast	78,428	42,725	17,320	13,387	12,018
South Atlantic	62,812	43,581	29,204	6,412	7,965
East Gulf	105,388	73,313	18,709	4,335	50,269
West Gulf	123,926	36,736	2,921	20,678	13,137
St. Lawrence	84,616	42,246	5,029	4,112	33,105
Hudson Bay	24,960	6,400	66	81	6,253
Total	480,130	245,001	73,249	49,005	122,747
Mississippi River Basin:					
Upper Mississippi	119,586	28,094	5,694	4,429	17,971
Ohio River	130,421	45,391	35,919	7,569	1,903
Missouri River	327,447	28,642	20,515	6,769	1,358
Arkansas-Red	176,981	52,220	34,560	15,525	2,135
Lower Mississippi	33,720	17,854	6,857	1,877	9,120
Total	788,155	172,201	103,545	36,169	32,487
West:					
California	70,744	29,780	21,056	3,736	4,988
Colorado	154,880	45,070	36,196	8,829	45
Rio Grande	108,160	17,460	14,168	3,292	----------
Great Basin	138,455	19,534	5,513	12,021	2,000
Columbia	131,119	59,025	38,745	18,180	2,100
Pacific Cascade	31,648	26,487	15,564	9,509	1,414
Total	635,006	197,356	131,242	55,567	10,547
Grand total	1,903,291	614,558	308,036	140,741	165,781

The fact that the extent and character of the forest cover, as well as stream flow and erosion, are controlled in part by the quantity and distribution of precipitation makes it difficult to draw deductions from gross acreages such as are given in table 1. It may be noted that in the Pacific Cascade drainages, with steep slopes and heavy rainfall but with about 90 percent of the total area in forest, mostly dense, floods and erosion are no great cause for concern, while in the Colorado River Basin, with much lower rainfall but with less than one third of its area in forest of a lighter type, floods and erosion are serious. More localized comparisons are given in the watershed description section. The effect of forest destruction on run-off is indicated by studies at the Red Plains Erosion Experiment Station in Oklahoma, where a plot from which the forest litter had been burned produced more than 100 times as much run-off as a similar unburned plot; its effect on erosion is indicated by a study of Hoyt and Troxell in California, in which the flood flows from burned watersheds were found to contain 20 to 67 percent of ash and silt.

The Great Basin, with only 14 percent of its area forested and only 28 percent of this classed as of major influence, developed a serious flood and erosion situation only after the forest and other vegetative cover was reduced by overgrazing and fire. Similarly, in the Ohio River Basin, 35 percent of which is in forest, the silting problem and increased frequency of floods have followed misuse of the land by man.

Erosion is a geologic phenomenon older than the hills, yet in each region the original vegetative cover was usually sufficient for soil building. Reduction of the cover through timber cutting, fire, over-

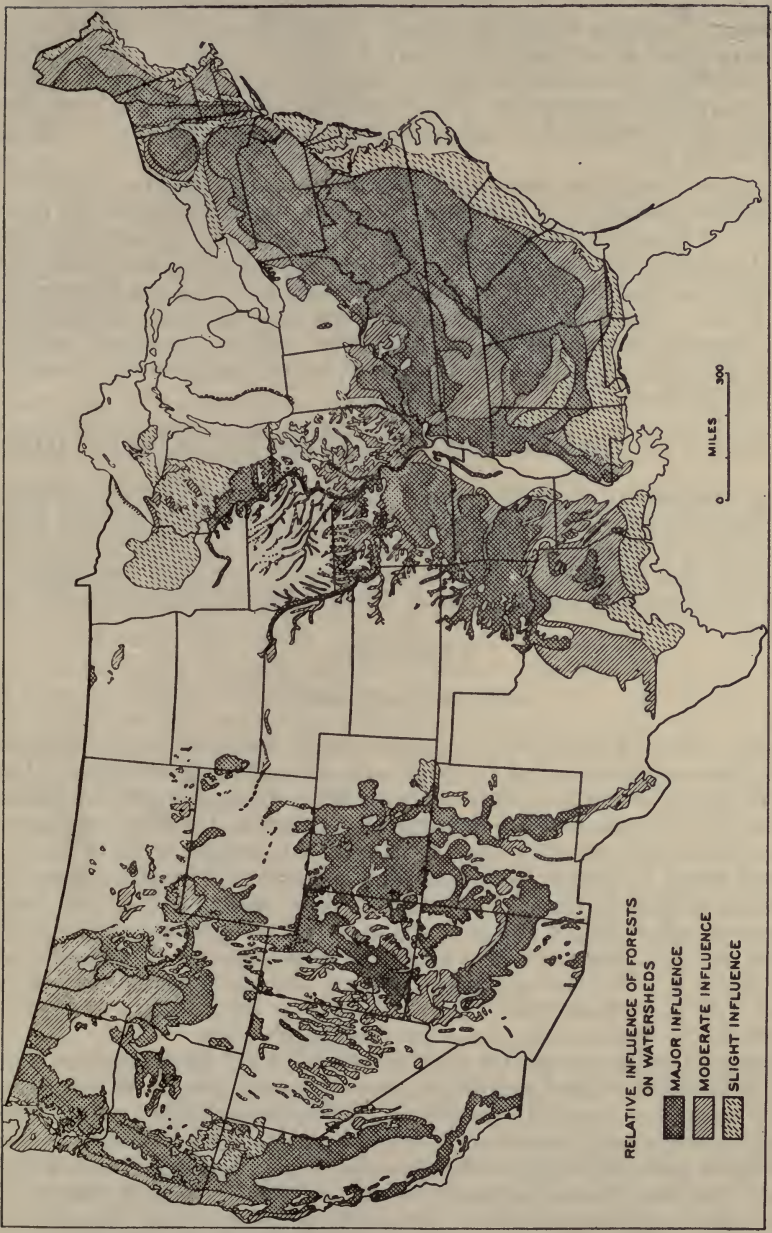
RELATIVE INFLUENCE OF FORESTS ON WATERSHEDS
MAJOR INFLUENCE
MODERATE INFLUENCE
SLIGHT INFLUENCE
MILES
0
300

FIGURE 1.—Forests of slight, moderate, and heavy influence on watershed protection. The ''breaks'' and ''badlands'' not shown.

grazing, and cultivation has often not only prevented soil building but diminished the fertility of the existing soil and impaired its ability to produce cover of the original type. This condition is illustrated by data from an area in Mississippi studied by the Southern Forest Experiment Station where 23 tons of topsoil per acre were lost from cultivated land as compared to only a trace of soil lost from forest land. Erosion cannot be completely stopped, but by restoring forest or other vegetative cover on the steeper and more critical areas the process can be retarded to a rate less than that at which fertility is added to the soil.

In each of the major drainage basins, bad conditions of stream flow and erosion now exist. On an immense area the forest cover has been reduced or removed by fire and improper cutting. The vegetative cover has too often been depleted by improper grazing methods, and the fertile topsoil has been washed from millions of acres of agricultural lands. The result of this land treatment has been higher and more frequent floods, silted reservoirs and stream channels, accentuated difficulties during periods of low water, and reduced productivity of the land.

RELATION OF OWNERSHIP TO WATERSHED CONDITIONS

Land ownership, more than any other one factor, has determined the differences in present watershed conditions. The degree to which watershed requirements have been met on land in various types of ownership and the sort of action necessary to establish satisfactory watershed management in each of these types are substantially as follows:

PRIVATE

AGRICULTURAL LAND

In the eastern half of the United States the most acute stream-flow and erosion problems exist on land now classed as agricultural. On such land, according to rough calculations, perhaps 70 percent of the erosion takes place and 40 percent of the water troubles originate. As has been pointed out in the section of this report entitled "Agricultural Land Available for Forestry", more than 50 million acres of agricultural land in the United States is now abandoned or idle, and present trends indicate the abandonment of an additional 25 or 30 million acres in the next 20 years. Largely because of removal of fertile topsoil, often through sheet erosion, the productivity of nearly all the land now abandoned was reduced below the point at which the land could be used economically for crop production.

Sheet and gully erosion on agricultural land are by no means confined to abandoned land and land approaching abandonment. Under present cropping methods erosion is the usual condition, and unless present practices are remedied more and more of the fertile soil from farm lands generally will be added to the silt load of our streams and rivers. On land suited for agricultural use, the problem is one to be solved by agriculture rather than by forestry. The Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering, individually, in cooperation with States, are working on the agricultural land phases of the erosion problem. Further reference here to the control of erosion on agricultural land will be omitted.

Among the worse situations as regards erosion are those described in detail for the South Atlantic drainages, where at least 5 million acres out of a total of 46 million acres of farm land is so seriously eroded that cropping must be discontinued; the Yazoo River silt loam uplands of the lower Mississippi River drainage, where 783,000 acres out of a total of about 2½ million acres of crop land is being seriously eroded; and the glaciated section of Illinois, where about 7½ million acres out of a total of 31 million acres is in a similar condition. The same condition exists on smaller portions of most of the eastern drainages.

These conditions are in part the result of cultivation on slopes so steep and soils so erosive that destructive washing was inevitable. Failure to hold the soil on lands that could have remained in agriculture by contour plowing, terracing, and proper crop rotation has been another contributing factor. We are now faced with the problem not only of putting this once productive land to use but also of preventing it from doing positive damage through increased contribution to run-off and through the silting of stream channels. That this land does accentuate these two problems immensely is shown by many experimental results reported in the watershed description section of this report.

Since private ownership did not meet watershed requirements on these lands even while they had agricultural value, obviously it can not be expected voluntarily to assume the expense of rehabilitating any great part of the lands or of controlling erosion and stream flow from them. The situation calls for public acquisition and management of areas that can be blocked up into feasible administrative units and of smaller units where the silt contribution is extremely large and where private initiative plainly can not be expected to correct conditions. Small isolated tracts normally should be taken care of in private ownership with some degree of public aid. Public acquisition can come in part through tax delinquency and in part through gift or purchase. In any event the cost per acre should not be high. The area of lands once farmed that should be repossessed by the public is believed to be almost 22 million acres.

On a large part of this land a cover of grass, weeds, brush, and trees sufficient to hold the soil will come in naturally if cropping is permanently eliminated and the cover is protected from fire and overgrazing, but on some 10 or 11 million acres in more humid regions the gullying that has started can best be stopped by planting trees.

FOREST LAND

Private ownership of forest land has usually carried with it no consciousness of an obligation to manage the lands so as to maintain or improve watershed conditions. In cutting timber it has generally been the owner's purpose to harvest the existing timber and dispose of the cut-over land as soon thereafter as possible. The section of this report entitled "Current Forest Devastation and Deterioration" has stated that about 10 million acres of private timberland is cut over annually. Only a small part of this is cut in such a way as to bring about perpetuation of the forest. Cutting practices designed to promote natural reproduction have been adopted on only about 10 million of the 444 million acres of privately owned forest lands. That present owners do not intend to retain possession permanently is implied by the fact that, even prior to the present depression, great areas of cut-over land in the Lake States, the South, the Pacific Coast, the northern Rocky Mountains, and other regions had become tax delinquent.

Too often, logging methods have been used that were extremely damaging to young growth left standing and that induced rapid run-off and erosion. Broadcast burning of slash in the ponderosa pine and other types has been curtailed in recent years only.

Fire control on private timberlands is inadequate in all regions of the United States with the possible exception of the northern and southern Rocky Mountains. (See table 5 of the section of this report entitled "Protection Against Fire.") The best available data show that only about 54 percent of the 412 million acres of private timberlands needing protection are receiving it. More than 150 million acres of private forest land in the 11 Southern States and more than 35 million acres in the Central States receives no protection. Partly as a result of this fact, the area burned over annually in the 5-year period 1926–30 averaged more than 37½ million acres in the South and 1,379,000 acres in the Central States. Recently in some western regions there has been a tendency to withdraw protection from cut-over lands where such action does not jeopardize virgin timber.

Grazing on private timberlands has likewise failed to meet watershed requirements. In the East, grazing use of woodlands has often been so heavy as to destroy the litter cover, pack the soil, and prevent the establishment of young trees in the stand. The watershed description section has shown that this treatment increases run-off and in some instances causes erosion. In the West, where range forage on timberland is usable it has been sold without serious attempt to regulate use in such a way as to maintain the vegetative cover. The proportion of the 228 million acres of privately owned forest land used as pasture on which watershed management receives even incidental consideration is insignificant.

Partly as a result of the practices just mentioned, about 56 million acres of privately owned forest land in the United States has been devastated. The Lake States with 12 million acres, the South with 23 million acres, and the Northeast with 5 million acres of such devastated land clearly illustrate the lack of concern for forest values.

So long as the treatment of private land does not damage other land, or the public, public intervention is not called for. Where bad management will result in irregular stream flow, floods, erosion, or silting, or otherwise damage public or private property, certainly management restrictions are justified. They cannot properly be applied, however, unless the public is willing to bear its share of the expense which such action may entail. As an alternative to regulation the only recourse seems to be public acquisition of critical watershed areas. This is discussed in detail in the section of this report entitled "Public Regulation of Private Forests." It is estimated that approximately 155 million acres of major-influence watershed land should be acquired by the public in order to safeguard public welfare. The distribution of this land by regions is shown in table 9.

The importance of privately owned forest land to watershed protection is shown in table 2. Certainly, with a total of 297 million acres of privately owned forest land classified as of high and moderate watershed influence, the condition of such land is a matter of public concern.

TABLE 2.—*Watershed-protective influence of privately owned forests*

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	Acres	*Acres*	*Acres*	*Acres*
Northeastern	38, 587, 000	14, 544, 000	12, 601, 000	11, 442, 000
South Atlantic	42, 137, 000	28, 444, 000	5, 913, 000	7, 780, 000
East Gulf	72, 187, 000	18, 480, 000	4, 248, 000	49, 459, 000
West Gulf	36, 588, 000	2, 916, 000	20, 588, 000	13, 084, 000
Lower Mississippi	17, 842, 000	6, 847, 000	1, 877, 000	9, 118, 000
Arkansas-Red	48, 775, 000	32, 040, 000	14, 871, 000	1, 864, 000
Ohio	43, 532, 000	34, 268, 000	7, 429, 000	1, 835, 000
Upper Mississippi	26, 730, 000	5, 624, 000	4, 329, 000	16, 777, 000
St. Lawrence	34, 696, 000	4, 828, 000	2, 764, 000	27, 104, 000
Hudson Bay	5, 513, 000	66, 000	76, 000	5, 371, 000
Missouri River	14, 483, 000	12, 262, 000	1, 521, 000	700, 000
California	13, 753, 000	10, 009, 000	2, 086, 000	1, 658, 000
Colorado	6, 482, 000	2, 844, 000	3, 638, 000	----------
Rio Grande	7, 787, 000	6, 154, 000	1, 633, 000	----------
Great Basin	3, 851, 000	1, 856, 000	1, 497, 000	498, 000
Columbia	17, 189, 000	12, 438, 000	4, 743, 000	8, 000
Pacific Cascade	14, 225, 000	8, 576, 000	4, 781, 000	868, 000
Total	444, 357, 000	202, 196, 000	94, 595, 000	147, 566, 000

TOWN, MUNICIPAL, AND COUNTY

Town and municipal forests, which total 473,765 acres in the United States, are in general very well cared for. Usually they have been established for watershed protection. They are policed and protected, and cutting and grazing are either banned or so regulated as to permit maintenance of favorable cover conditions. Denuded lands are usually planted as acquired.

While no attempt has been made to determine what acreage should ultimately be in municipal forests, it may be said that the area should be greatly increased. This is especially true of city watershed lands. The responsibility is localized and very direct. Often the acquisition and maintenance of a watershed area is no less definitely the responsibility of a city than the building of the conduit through which the water reaches the city mains.

In many sections of the United States large acreages of forest lands are reverting to the local governments for nonpayment of taxes. In most States these lands revert to the county; in a few they revert to the town or the State. For the sake of brevity they are all here considered as county land. Such lands are in both large and small blocks, and in most instances have been cut over, burned, or devastated. Where actually organized for administration these lands are satisfactorily handled. The greater part are not so organized and are given little attention other than fire protection. Particularly in agricultural districts, the land that has reverted or is reverting to the public is largely land that has been used for agriculture but that through one cause or another is no longer profitable for such use. In many cases, as has already been stated, erosion has been a primary cause of reversion.

These tax title lands, both forested and agricultural, often spoken of as the "new public domain", are returning to public ownership in a very poor watershed condition and frequently must be given special attention if they are to perform any worthwhile service. Most of them should not be returned to private ownership. They should be blocked as public forests, and the public should assume the full responsibility of ownership. Trees should be planted on them if necessary, fire protection should be provided, and such practices as promiscuous cutting or too heavy grazing use should be prohibited.

Where the financial burden of properly caring for these lands is too heavy for the resources of the local government, the larger block at least should be taken over and managed by the State. Some of the lands are so located that it would be logical to include them in national forests or, where suitable, in national parks.

STATE

State-owned forest lands total more than 13 million acres, including 4,395,549 acres of State forests, 2,682,509 acres of State parks, and 6,140,106 acres in other status.

In the Pacific Coast and Rocky Mountain States, State ownership generally goes back to Federal land grants made without regard to the major purpose which the land should serve. In New England and the Middle Atlantic States, State ownership has more often resulted from direct acquisition and in some instances is based in part on watershed-protection needs. In some regions, including the Lake States, State ownership has resulted in part through Federal grant, in part through purchase, and in part through tax delinquency. Obviously, in such cases watershed value was not the primary basis of selection. Table 3 shows by regions the watershed-protective influence of forest lands in State, municipal, and county ownership.

TABLE 3.—*Watershed-protective influence of forests on State, county, and municipal lands*

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	Acres	*Acres*	*Acres*	*Acres*
Northeastern	3, 545, 000	2, 500, 000	500, 000	545, 000
South Atlantic	232, 000	100, 000	82, 000	50, 000
East Gulf	250, 000	50, 000	5, 000	195, 000
West Gulf	148, 000	5, 000	90, 000	53, 000
Lower Mississippi	12, 000	10, 000	----------	2, 000
Arkansas-Red	105, 000	70, 000	14, 000	21, 000
Ohio	282, 000	150, 000	64, 000	68, 000
Upper Mississippi	1, 175, 000	70, 000	100, 000	1, 005, 000
St. Lawrence	5, 115, 000	200, 000	1, 328, 000	3, 587, 000
Hudson Bay	17, 000	----------	5, 000	12, 000
Missouri	411, 000	200, 000	163, 000	48, 000
California	121, 000	111, 000	----------	10, 000
Colorado	1, 797, 000	1, 200, 000	595, 000	2, 000
Rio Grande	1, 069, 000	1, 000, 000	69, 000	----------
Great Basin	122, 000	15, 000	5, 000	102, 000
Columbia	2, 021, 000	835, 000	1, 000, 000	186, 000
Pacific Cascade	1, 058, 000	500, 000	227, 000	331, 000
Total	17, 480, 000	7, 016, 000	4, 247, 000	6, 217, 000

Most State lands organized as State forests or parks are so managed and protected that watershed values are maintained and improved. In some Eastern States cutting is closely supervised, grazing is restricted, fire is virtually excluded, and most of the denuded areas have been planted. In some States, because of lack of interest in State forests, protection is inadequate, grazing and cutting are virtually unregulated, and little if any progress has been made in reforesting denuded lands.

State-owned forest lands outside State forests and parks in some instances are given little or no administration. Many of these holdings are so widely scattered and in such small parcels as to make management somewhat difficult. In many of the Western States these lands are leased for grazing on an acreage basis without any restrictions as to numbers of stock to be pastured or season of use. In some instances timber is sold by estimate and cutting is not supervised. State lands inside national-forest boundaries, however, are often given protection and other management under cooperative agreements with the Forest Service. In some States there exists a State forestry organization capable of expanding sufficiently to place all State-owned forest lands under administration.

The acreage of organized State forests should be increased greatly. Much increase promises to come about through tax delinquency. An aggressive purchase and exchange program should be formulated to provide that the tax-reverted holdings will be consolidated for efficient management.

Since a large acreage of devastated forest land and submarginal agricultural land will inevitably find its way into State ownership, many of the forested States are faced with the necessity of financing a large program of reforestation and fire protection in order to rebuild watershed values. The division of responsibility for such activities among the various public agencies is discussed in some detail in the section of this report entitled "The Probable Future Distribution of Forest Land Ownership."

FEDERAL

NATIONAL FORESTS

On the national forests, a desirable type of administration is provided for a large area of forest and related wild land. As shown in table 4, the national forests with a net area of 140,003,966 acres, have 107,773,000 acres in forest. Of this forested area 70 percent has high watershed influence, 24 percent has moderate influence, and only 6 percent has slight or no influence. By far the greater part of this land is located in mountainous sections at the headwaters of major streams.

TABLE 4.—*Watershed-protective influence of national forests*

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	M acres	*M acres*	*M acres*	*M acres*
Northeastern	532	266	266	----------
South Atlantic	1,057	640	417	----------
East Gulf	757	80	82	595
Arkansas-Red	2,569	2,450	69	50
Ohio	1,276	1,200	76	----------
Upper Mississippi	189	----------	----------	189
St. Lawrence	1,810	1	----------	1,809
Missouri	9,166	6,103	3,000	63
California	13,127	9,466	1,500	2,161
Colorado	21,913	19,870	2,000	43
Rio Grande	5,364	4,864	500	----------
Great Basin	6,670	3,000	2,670	1,000
Columbia	34,755	22,000	11,933	822
Pacific Cascade	8,588	5,188	3,400	----------
Total	107,773	75,128	25,913	6,732

Fire protection is given all national-forest lands, although in some regions it has not reached a satisfactory standard. The action necessary to meet the minimum standards is discussed in detail in the section of this report entitled "Protection Against Fire." In the 5-year period 1926–30, for the entire national-forest system the area actually burned over was only 7 percent more than the allowable burn; in the Middle Atlantic States and Pacific Coast States, however, the acreage burned was 3.8 times and 2.8 times, respectively, as great as the allowable acreage, and on about 30 million acres of critical areas in the South, Pacific Coast, and Northern Rocky Mountain Regions the area burned was about five times as large as that which could be accepted as satisfactory.

Timber cutting on the national forests is usually handled on the selection system, which is most satisfactory from a watershed standpoint. In certain types, particularly the Pacific Coast Douglas fir and mature western white pine, the present cutting practice is not entirely satisfactory from a watershed-protection standpoint, but the condition of the virgin stand being cut seems to demand that the present practices be continued. Fortunately in both instances, owing to the humid climate, as discussed in the watershed description section, rather complete revegetation follows cutting very quickly.

Denuded lands are being planted as rapidly as funds will permit. Planting operations to date have covered more than 300,000 acres, and the program now outlined calls for the planting of 2,100,000 acres in the next 20 years. This work is progressing slowly and should be greatly speeded up.

National-forest range lands as a whole are safeguarded from improper use, although in some places grazing practices do not adequately safeguard watershed values or permit the vegetation rapidly to reclaim lands injured before the forests were established.

On the whole, national-forest administration takes into account the needs of watershed protection and in a very practical way applies the available information as to protection of watershed values. Administration is constantly improving, and it is reasonable to expect that the national forests will continue to exert an increasing beneficial influence upon soil and water conditions. As is shown in the section of this report entitled "Research in the United States Forest Service", much research is needed to determine definitely the best methods of handling watershed lands. The national forests, including most of the conditions to be studied, provide an excellent field for this work.

That the acreage of national-forest land must be greatly increased if watershed values are to be preserved is clear. The benefits from watershed protection are largely public, and it cannot be expected that private ownership will bear the burden of proper management unless it pays immediately. In most cases, local governments cannot be expected to finance projects of interstate or national significance. The most desirable division of ownership among agencies is discussed in detail in the section entitled "The Probable Future Distribution of Forest Land Ownership."

INDIAN LANDS

Lands in Indian reservations are not, on the whole, given the best possible management from a watershed standpoint. The objectives of timber management are substantially the same as on the national forests. Fire control has been seriously handicapped by lack of adequate funds. Steps have been taken to correct the serious overgrazing which has been practiced on some reservations. The indeterminate status of Indian lands, discussed in the section of this report entitled "The Indian Forests", is chiefly responsible for defects in management. As is shown by table 5, of the 15 million acres of Indian forest land nearly 70 percent is classified as having high watershed influence.

TABLE 5.—*Watershed-protective influence of forests on Indian lands*

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	M acres	*M acres*	*M acres*	*M acres*
Ohio	56	56		
St. Lawrence	410		20	390
Hudson Bay	870			870
Missouri	1,490	730	460	300
California	985	102	150	733
Colorado	8,493	7,797	696	
Rio Grande	400	350	50	
Great Basin	10	10		
Columbia	2,225	1,725	250	250
Pacific Cascade	480		480	
Total	[1] 15,419	10,770	2,106	2,543

[1] This figure includes some 6,772,000 acres of noncommercial forest, mostly of the piñon-juniper type in Arizona and New Mexico.

NATIONAL PARKS AND NATIONAL MONUMENTS

National parks and monuments are generally handled in a way that meets watershed requirements. Commercial use of all kinds is greatly restricted, and in only a very slight degree is this regulated use at variance with best watershed-protection practices. Grazing is gradually being excluded. Commercial cutting is entirely excluded. Fire protection in most of the parks is now of about the same standard as that on the national forests. More than 90 percent of about 4½ million acres of land in national parks and monuments has major or moderate watershed influence, as is shown in table 6. Watershed conditions on these lands are good and are rapidly improving.

TABLE 6.—*Watershed-protective influence of forests on national park and monument lands*

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	M acres	*M acres*	*M acres*	*M acres*
Northeastern	12	10		2
Arkansas-Red	1		1	
Ohio	220	220		
Missouri	1,654	154	1,500	
California	828	828		
Colorado	387	387		
Rio Grande	20		20	
Columbia	1,059	600	109	350
Pacific Cascade	239	100	139	
Total	4,420	2,299	1,769	352

PUBLIC DOMAIN

Conditions on the unreserved and unappropriated public domain are in decided contrast to those on the classes of Federal lands just discussed. The best available estimates show that 25 million acres of the 173,318,246 acres of the public domain and the Oregon and California Railroad and Coos Bay Wagon Road grant lands is forested. Of the forested land 91 percent has moderate or high protective influence, as is shown in table 7.

TABLE 7.—*Watershed-protective influence of forests on public domain and other Federal lands* [1]

Drainage	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*
Northeastern	49	---	20	29
South Atlantic	155	20	---	135
East Gulf	119	99	---	20
Arkansas-Red	770	---	570	200
Ohio	25	25	---	---
St. Lawrence	215	---	---	215
Missouri	1,438	1,066	125	247
California	966	540	---	426
Colorado	5,998	4,098	1,900	---
Rio Grande	2,820	1,800	1,020	---
Great Basin	8,881	632	7,849	400
Columbia	1,776	1,147	145	484
Pacific Cascade	1,897	1,200	482	215
Total	25,109	10,627	12,111	2,371

[1] Including Oregon and California and Coos Bay land grants.

The condition and management of these lands are discussed in detail in the sections of this report entitled "The Public Domain and Other Federal Forest Lands" and "Forest Ranges." These lands are without administration or purposeful management. They suffer from all the evils of improper grazing use, and where timber cutting takes place no provision is made to prevent devastation. Fire protection is entirely lacking on a large part of the watershed lands, and where given is adequate.

Slightly more than 19 million acres of these lands, because of location and character, might logically be added to existing national forests. An additional area in excess of 3 million acres might well be given national-forest status as new units or held for inclusion in the national forests at a later stage in the national-forest acquisition program. Administration of these lands as portions of national forests would increase the stability of the livestock industry and thus greatly encourage better handling of intermingled or nearby private land, thus making watershed management more effective generally. The bulk of these lands should be included in public grazing reserves and given such administration as would preserve and improve the watershed values.

The proper administration of these lands would promote improvement of watershed conditions in the West perhaps more than any other single measure.

The watershed-protective value of forests in all ownerships is summarized in table 8.

TABLE 8.—*Watershed-protective value of forests in the United States by ownership*

Ownership	Total forest area	Forest area by watershed-protective influence		
		Major	Moderate	Slight or none
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*
National forests	107, 773	75, 128	25, 913	6, 732
Indian forests	15, 419	10, 770	2, 106	2, 543
National parks and monuments	4, 420	2, 299	1, 769	352
Public domain and other Federal land	25, 109	10, 627	12, 111	2, 371
State, county, and municipal	17, 480	7, 016	4, 247	6, 217
Private	444, 357	202, 196	94, 595	147, 566
Total	614, 558	308, 036	140, 741	165, 781

MAJOR CRITICAL SITUATIONS

A single watershed problem may be common to parts of several drainages. For example, watershed conditions in the piedmont and upper coastal plain sections from the Potomac River around the Atlantic seaboard to Texas form a single problem, and so do those in the semiarid woodlands throughout the West. In order to avoid repetition, statements as to major critical watershed situations will be based on representative groups of conditions rather than on the drainage divisions previously used. No attempt will be made here to cover the entire country or to present statistics in such a way as to make possible a summation into national totals.

MISSISSIPPI BLUFF LANDS AND SILT LOAM UPLANDS

The bluff lands of the Mississippi River and the lower reaches of its main tributaries form a narrow belt extending from New Orleans to St. Paul, through the lower Mississippi, Ohio, Missouri, and upper Mississippi River drainages. They are the steep, broken slopes and adjacent silt loam uplands that flank the river terraces. They total about 20 million acres, of which two thirds lies below the mouth of the Missouri River, and are characterized by windblown and silt loam soils.

These bluff lands are believed to contribute more to the silt problem of the Mississippi River than any other area of the same size. The greatest watershed problem here is erosion, although flood control is almost equally important. The high erosibility of the soils naturally favors the formation of deep gullies, which spread with exceptional rapidity and are most difficult to check. This is particularly true in the Yazoo River uplands, in the southern tip of Illinois, and in the bluff lands of southwestern Wisconsin and of adjoining areas in Minnesota, Iowa, and Illinois. In some counties of the Yazoo uplands as much as 40 percent of the area is badly gullied, the gullies reaching in many cases to a depth of 20 or 40 feet and in some cases to more than 100 feet.

Originally almost unbroken, the forest stands have been reduced by fire, grazing, lumbering, and clearing for agriculture by approximately 75 percent in the South and by an even greater proportion in the North.

The erosion problem here is very largely the consequence of improper agricultural practices. It has resulted in part from cropping land that never should have been cleared and in part from using improper cropping methods on good agricultural land. Principally as a result of these two practices about one sixth of the agricultural area has already been abandoned and active erosion is continuing on about one fourth of this abandoned land.

Special measures to check erosion are needed now on upwards of 1 million acres of the bluff lands, and unless present bad practices are quickly corrected will be needed on an even larger area. The volume of soil being eroded from these areas each year is inconceivable. A single rain on experimental plots near Holly Springs, Miss., for example, removed soil at the rate of 23 tons per acre from cultivated land with a 10 percent slope. Studies in southwestern Wisconsin have resulted in an estimate that an area of 10,000 square miles in Wisconsin and Minnesota contributes 15 million tons of silt to the Mississippi River annually. In both sets of experiments erosion from forested soils was insignificant compared with that from barren or cultivated soils. While these figures may or may not be extreme, they establish clearly the importance of erosion control on bluff lands if the Mississippi River silt problem is to be solved.

The same studies showed the effectiveness of the forest cover in controlling run-off. The percentage of the precipitation that ran off immediately from cultivated plots as compared with that from forested plots was about 130 times as large in Mississippi and about 12 times as large in Wisconsin.

The situation on forested lands, while far from satisfactory, is in general not wholly bad. Particularly in the South, fires occur commonly in the bluff lands and destroy the leaf mold and litter so necessary to watershed protection. In the State of Mississippi as a whole the acreage burned over annually averages more than 40 times the allowable burn. The percentage burned in the bluff lands is not much below the State average. Timber cutting, while usually falling short of devastation, has been too heavy to permit the forest to exert its full watershed-protective influence, and grazing has injured the forest cover on many areas.

Solution of the erosion and flood problems of the bluff lands, essential both locally and nationally, appears to require (1) lifting from agricultural use land that is submarginal for that use; (2) reforesting, by planting, the 650,000 acres of land on which erosion will otherwise continue; (3) providing adequate fire protection on timberlands; and (4) installing special mechanical erosion checks where necessary.

There is little hope of obtaining proper watershed conditions on this land in private ownership, because the expense incidental to proper management will not be returned as a direct financial profit to the individual owner. To obtain such conditions will necessitate public acquisition of a large acreage of submarginal farm and forested land. On the timberlands that remain in private ownership, fire protection should be materially strengthened, through public aid and extension.

The damage that results from conditions within this narrow belt along the river obviously is of national interest. The navigability of the river, its interstate character, and the magnitude of the Mississippi flood problem call for national action. Individual States affected should, of course, assume part of the direct responsibility, but the major part of the control program should and must be carried by the Federal Government.

PIEDMONT AND UPPER COASTAL PLAINS

Erosion and floods are the two outstanding watershed problems in the piedmont and upper coastal plain sections, which include the critical situation not only in the southern Atlantic drainages but in the east Gulf drainages as well. The serious conditions are largely confined to the highly erosible deep clay to loam soils of the piedmont and the somewhat similar soils found on parts of the upper and more hilly portion of the coastal plain. Rainfall is abundant, varying from about 35 inches in the upper Potomac to 80 inches farther south. As much as 22 inches of rainfall has been recorded in an individual storm.

The forest cover, originally almost complete, now extends over only about two thirds of the total area, the forested proportion varying among the larger drainages from 50 percent to 75 percent. Organized fire protection has been provided for only a small part of the forest, and in the 5-year period 1926–30 the average annual burn for the States included was nearly 15 times the allowable burn.

The major problem has to do with the land that has been cleared and used for agriculture. With as much as 80 percent of the land in the charge of tenants, largely irresponsible, cropping has not been handled skillfully. Fields have been plowed up and down hill instead of along the contour or in terraces; cotton, corn, and tobacco have been grown under clean tillage year after year, the soil being left without cover during the period of greatest rainfall. Reduction of productivity by sheet erosion and destruction of productivity by deep gully erosion have resulted in widespread land abandonment. Within the east Gulf and South Atlantic drainages at least 8½ million acres of land has been abandoned in the past 20 years, and present trends indicate that abandonment may reach 12 million acres by 1950.

Fortunately the climate and the ease with which the southern pines reproduce favor rapid revegetation of abandoned land. It is believed that as much as two thirds of the abandoned land may be reclaimed by natural forest or by weeds and grass if left undisturbed. This would reduce to perhaps 2½ or 3 million acres the area demanding treatment within the next 20 years if erosion is to be controlled. On this area tree planting is the logical solution.

It will be difficult to obtain on privately owned forest the type of management that will adequately meet the erosion and stream-flow situation. It will be practically impossible under private ownership to carry through a program of reforestation and engineering works on idle land such as the situation demands unless the public pays the costs. For the Government to attempt to control the clearing and cultivation of lands that if so treated would be subject to destructive erosion would be impractical so long as the lands remained in private ownership.

Public acquisition and management of a large part of the eroding farm lands and the major-influence forest land appears to be the only adequate solution. Heavy Federal participation in this project is fully justified by the effect of the present situation on the maintenance of navigable rivers.

CENTRAL STATES ABANDONED FARM LANDS

Abandoned farm lands of the Central States region, although in many sections intermingled with true forest land, constitute a watershed situation that requires special consideration. Conditions vary greatly among different parts of the region. In general, the unglaciated and therefore more hilly areas are most in need of attention. Elsewhere in these States soil depletion and erosion may be a serious matter but it is a problem for agriculture to solve, with forestry playing only a minor part through reforestation of small critical areas and through better management of farm woodlands on many farms.

The sections where conditions are most critical and where forestry may aid materially (outside of the Mississippi River bluff lands, discussed separately) include West Virginia, western portions of Kentucky and Tennessee, southern parts of Indiana, Ohio, Illinois, and Missouri, and, to a lesser degree, northern Missouri, southern Iowa, and eastern Nebraska and Kansas.

Within the sections where erosion is most acute perhaps 15 million acres of farm land has already been abandoned and the trend has apparently only gotten under way. The major reasons for abandonment, apart from the present economic situation as it applies to farm lands, are (1) the clearing for agriculture of land that owing to steep slopes or naturally shallow or highly erosible soils should have remained in forest, and (2) failure to apply special treatment such as contour plowing, terracing, and proper crop rotation to land, the agricultural usefulness of which might thus have been preserved. On many areas erosion continues unchecked after abandonment, while on other areas idleness permits the establishment of a cover of weeds, grass, brush, or trees sufficient to hold the soil.

Decisive action is justified by average annual flood damage amounting to more than $4,000,000 on the Tennessee and Ohio Rivers and to much greater sums on the Mississippi River proper, by the silting of navigable streams to correct which literally hundreds of millions of dollars have been spent or are proposed for expenditure, and by the serious domestic water supply problem encountered during periods of drought.

At present practically the whole area, except land that has reverted to public ownership through tax foreclosure, is in private ownership. Certainly private owners cannot logically be expected to spend money to cure a condition on lands that they have abandoned, or when any benefits resulting from the treatment would accrue to the public rather than to the owners. Public financial aid or public acquisition is indispensible to progress. In many instances the financial aid needed would approach or might even exceed the value of the land itself. Therefore a program of public acquisition seems to be the practical way out.

Owing to the interstate character of the main streams and their relation to navigation and flood control the problem is national in scope, although some of its local aspects place responsibility on various public agencies in the several States. Certain of the States have enormous wealth, while others find it difficult to finance the usual functions of government. Some of the most critical situations are so located at the borders of States that, however important nationally, they have only minor significance for the State.

Obviously each agency involved should make the maximum equitable contribution. Private owners should handle situations in the farm-woodland class involving only a small part of their entire property; counties and municipalities financially able to do so should participate on areas not subject to blocking up for more specialized management; States should carry a large part of the burden, on the basis of responsibility for damage originating within their jurisdiction; finally, the Federal Government should assume the responsibility for large areas and for special conditions beyond the reach of local agencies.

With the dedication of these abandoned lands to watershed protection must go a planting program such as that set up in the section of this report entitled "Reforestation of Barren and Unproductive Land." Generally, planting should be concentrated at first on land that otherwise would continue to wash after cropping is eliminated. In very many cases this will mean only a small part of a farm otherwise in satisfactory condition. Farm-woodland planting is inexpensive, and besides contributing to watershed protection converts idle areas on the farm to a definite productive use. In most of the public planting timber production would be incidental to the benefits of erosion and flood control; it would be a real factor, nevertheless, in a region that imports great quantities of wood products. The use of land primarily for watershed protection usually need not eliminate timber cutting, game production, and recreational use.

Along with public acquisition and management must go improved fire protection on forest lands in all types of ownership.

COASTAL DUNES

The coastal dunes include sand dune lands along the eastern shores of Lake Michigan and other Great Lakes and in places along the Pacific, Atlantic, and Gulf coasts. Of special interest are the dunes of Cape Cod, Long Island, the New Jersey coast, Maryland, North and South Carolina, Florida, and Oregon. These dunes menace harbors, transportation systems, agricultural lands, summer homes, and other improvements. The individual areas are small. Taken together they may compose a strip several miles wide along a thousand miles of coast line, totaling probably half a million acres.

At the present time a very small area of dune land is in public ownership. Part of this is in parks such as those in northwestern Indiana and at San Francisco. The greater part is in private ownership.

The control of sand movement on coastal dune areas will require planting grasses and shrubs, scattering litter and other humus material, building sand fences and traps, and reforesting by many different methods.

Fire control in the dune region is relatively simple, because the cover is usually insufficient to carry flames. After dunes have been stabilized, however, such a cover can be developed as will be subject to destructive fires. On dune areas that are being stabilized, well-nigh perfect fire control should be maintained, because of the danger of loss of the cover.

In spite of the fact that their productive value is low, a considerable portion of the dune lands will be held for private development, largely as recreation areas or as estates. On such areas the use of fire should be closely restricted, cutting should be restricted to the removal of dead wood, and grazing use should be very closely restricted or entirely eliminated. Where feasible, dune lands should be taken into public ownership; only in exceptional cases can private ownership be expected to provide the type of management and protection required. Usually these areas have exceedingly high value for recreation, and the two purposes of soil fixation and recreation often can be served best through public control. Usually, Federal ownership should not be necessary.

NORTHEASTERN DRAINAGES

The Catskill, Adirondack, Green, and White Mountain watersheds involve about 40 million acres of timberland in the northeastern drainages, including the St. Lawrence drainage below the Great Lakes. Here domestic and industrial water supplies are the major reasons for concern, because of unusually heavy concentrations of population. The metropolitan centers have a population of more than 15 million and require more than 2 billion gallons of water daily. Some 25 percent of the Nation's developed water-power capacity is in the Northeast, and the commercial tonnage shipped on the principal rivers of the region exceeds that on the Mississippi between New Orleans and Minneapolis. Flood control is likewise of great importance.

Originally this area was a continuous forest; at present only 54 percent of it is classified as forested, and a very large part of the forest that remains is badly deteriorated. Reduction of soil fertility by continuous cropping and by erosion from cultivated fields, and the settlement of better agricultural areas in the West, have caused the abandonment during the last two decades alone of more than 10 million acres of agricultural land in the northeastern drainages. Some sort of natural vegetative cover quickly establishes itself on cut-over land or abandoned farm land where the soil is not disturbed, preventing destructive erosion.

Because of the great value of the forests of these drainages as a source of metropolitan water supplies, and because of the navigability of many of the streams and their importance in the industrial and economic life of the region, much land in the rougher sections of New England and New York should be in public ownership. Great watershed-protection and recreational values would thus be maintained or increased. The States included have not only a great concentration of population but also in some cases a great concentration of wealth. Therefore the necessity for Federal assistance in watershed protection is less pronounced than in most other regions of the East. Certainly the Federal Government should at least acquire ample land to demonstrate proper management for watershed protection.

New York now owns 2½ million acres of watershed land and is acquiring an additional million acres. Some 350 cities of New York now own watershed forests. Cities and towns of Massachusetts own more than 25,000 acres of such forests; Newark, N.J., has a watershed forest of 35,000 acres. Altogether, some 4½ million acres of forested watershed land in the region is in public ownership. This acreage should be increased very materially.

Private ownership of a large part of the watershed lands will and should continue. Timber values in this region, with proper management, make private forest-land ownership profitable, particularly on the more productive and more accessible sites. Fire protection, with public aid, is very nearly adequate. There is definite need, however, for a greatly expanded program of forest research and extension in order that timberland management may be improved.

APPALACHIAN MOUNTAIN CHAINS

The Appalachian Mountain chains include the Allegheny and Appalachian Mountains, the Cumberland Plateau, and the Blue Ridge. They extend southwestward from New York to northern Georgia and involve some 50 million acres. They contain the headwaters of the Susquehanna, James, Ohio, Tennessee, and other important navigable rivers. Where the slopes and soils permit, farming is common.

The greatest watershed problem in this region is irregularity of steam flow. Erosion, also, is extremely serious, particularly on farmed lands. The forests have been cleared, unfortunately, from a large acreage entirely too steep and too erosible for profitable agricultural use. Cultivated fields with slopes of more than 30 percent are not unusual. Because of erosion, such land is ruined for agriculture by a very few years' cultivation. For this reason agriculture is declining and land abandonment is prevalent.

Originally the Appalachian Mountain chain was almost wholly forested. Almost all its forest land has now been cut over and many parts have been culled repeatedly. While the forest has so depreciated in quality that much of it now has little commercial value, the ground has reclothed with a cover sufficient to control erosion when fires are kept out. The fire-protection record for much of the area to date is bad and public interest in meeting the need for adequate protection is in general lacking. Those who have studied watershed conditions on the ground in the Appalachian Mountains consider improvement of the forest and other vegetative cover necessary as a means of controlling silting and reducing flood damage.

Here again the problem is complicated by ownership. There is no reason to expect private owners to correct conditions on practically worthless abandoned farm lands, and little more hope that they will adequately protect timberlands. Apparently the logical solution is public acquisition of a very large share of the high-influence forest and abandoned farm land. Because of the interstate character of the streams the Federal Government should carry the greater part of the burden. There is ample opportunity for both State and Federal ownership.

With a large area in public ownership and with adequate control of the use of fire on private lands the situation should improve rapidly.

OZARK-OUACHITA

The Ozark-Ouachita area of Arkansas, Oklahoma, and Missouri includes the hilly to mountainous country of the lower Mississippi drainage. While these mountains have an area of only 45 million acres, composing less than 6 percent of the Mississippi River drainage, they are estimated to yield more than 25 percent of the flood flows of the lower river. More than 50 percent of the peak flow of May 1, 1927, came from this section.

Agriculture in this region started with the more level stream bottoms and gradually expanded to include more and more hillside land, where rapid run-off and excessive erosion naturally followed. Much of this hillside agricultural land is now definitely submarginal and is being abandoned. Erosion, while not so spectacular as that of the Mississippi River bluff lands, is widespread on hill lands used for cultivated crops. On much of the land, fortunately, abandonment is followed rather promptly by the development of a cover of grass or, where seed is available, of forest.

The forest of mixed pine and hardwoods in the mountains and pure pine in the foothills originally was almost continuous. Repeated fires, local overgrazing, extensive lumbering, and clearing for agriculture have reduced the forest area to possibly one half its original size and deteriorated the remainder to a point at which its influence on run-off and on erosion is seriously impaired. Fires are exceedingly prevalent and prevent the maintenance of a good forest and litter cover. It is estimated that approximately one seventh of the major-influence watershed forests are burned over each year. Obviously, under such treatment good watershed conditions cannot exist.

Bad as conditions may be on the burned mountain forests, they are much more serious on the cultivated portion of the area. The more level cultivated lands can no doubt be maintained by proper cultivation methods, but the hillside fields must ultimately be abandoned. In some situations only a few crops can be raised before the top soil is sluiced off. Certainly this type of agriculture is not in the public interest and should be stopped.

A small part, about 1,250,000 acres, of these mountain forests is national-forest land. On these lands watershed protection is the primary purpose of management, and while conditions are not yet satisfactory they are improving. The condition of the very limited area of organized State forest is likewise improving. The rest of the land is in private ownership, and it is here that watershed problems are greatest.

Correction of the existing conditions depends on (1) improved fire protection and (2) proper management of major-influence forest and critical agricultural lands. Foresters and others personally familiar with conditions in these mountains substantially agree that erosion can be diminished and stream flow made more regular by improving the forest and vegetative cover. Public acquisition of major-influence land would aid in accomplishing this end.

The problem is so largely one of preventing floods and silting in the lower Mississippi River Basin that the responsibility is largely Federal. The States concerned should not be expected to carry any considerable part of the acquisition program. They should, however, take the lead in improving forest-fire conditions on private lands.

BREAKS AND BAD LANDS

The Breaks and Badlands include more than 20 million acres on the Arkansas, Red, and Brazos Rivers to the south and on the

Missouri River to the north. These areas are characterized by steep, broken topography, extremely erosible and generally unproductive soil, low annual precipitation, and sparse vegetation ranging from grassland types to stunted, noncommercial tree growth. Much of the area is range rather than true forest land and is included in this report only because of the extent to which it contributes to the silt load of the Mississippi River and its tributaries and because many of the problems involved are common to watershed control on forest ranges generally. Erosion on these areas is great even under normal conditions and has been accentuated through misuse, largely overgrazing.

As a result of the low productivity of the soil, private ownership has not been attracted to this land. A high percentage of the area, except in Texas and Oklahoma, is in the public domain.

Erosion control here will be particularly difficult. Fire should be completely excluded, timber cutting should be restricted to dead and down timber or very light selective cutting at most, grazing should be greatly reduced and on many areas completely excluded, and where it is allowed the season of use should be carefully determined. Artificial revegetation with grass, brush, and trees will have to be studied and used where feasible. Finally, special engineering works to stop stream silting will have to be devised. Much research will be required on each phase.

Because of the restrictions in use required, obviously the situation can be corrected only under public ownership. This would mean acquiring lands now in private ownership, by purchase or exchange, and blocking them up with public lands into suitable administrative units. Federal rather than State control seems logical, because the silt contributions from these areas to the Missouri and Mississippi Rivers are of national rather than local concern. For example, the silt contribution to the Missouri River which comes from the Breaks in Montana is of little economic consideration in Montana, but is a real factor in States farther down the river. Placing the public domain under administration, as discussed in the section of this report entitled "Public Domain and Other Federal Forest Land", should result in active efforts toward solution of the watershed problem of the Breaks and Bad Lands. At best it will not soon be solved.

PACIFIC SLOPE DENSE FORESTS

Climatic conditions on certain areas of the Pacific slope are such as to cause the establishment of extremely dense forests with an unusually rank understory of small trees, ferns, and other low vegetation. This condition is especially marked in the redwood forest of northwestern California, in the Douglas fir and the fog-belt forests of western Oregon and Washington, and in the white-pine zone of the northern Rocky Mountain region. Undoubtedly, in a virgin condition these dark forests exert the maximum influence on stream flow and on soil stability.

Damage by fire is excessive. Particularly in the Douglas fir and white-pine zones, these forests present one of the most difficult problems in forest-fire protection. Acceptable protection standards have not been met even on the national forests. Fortunately, a new vegetative cover is rapidly established even following complete destruction of the forest by fire. Erosion, therefore, is not serious except in restricted local areas.

A large part of the white pine and Douglas fir forests is in private ownership and in general is being liquidated through exploitation as rapidly as possible. Apparently part of these lands will ultimately return to public ownership. Cutting on private land has not been designed to maintain watershed values, and this condition, coupled with the common occurrence of fire following logging, has markedly reduced the effectiveness of these forests in stream-flow regulation.

These dense forests are exceptionally productive, and therefore would justify intensive management for timber production. The correction of cutting practice and the improvement of fire protection to meet even minimum requirements for timber production would adequately protect watershed values involved. Certainly these two measures are justified.

PONDEROSA PINE-LODGEPOLE PINE BELT

The broad classification ponderosa pine-lodgepole pine belt includes the greater part of the commercial and subalpine forests of the West, excluding, of course, the more dense forests of the Pacific slope previously discussed. It includes the ponderosa pine forest with its various mixtures, the extensive lodgepole pine forests, the Rocky Mountain Douglas fir and spruce-fir forests, and the subalpine mixtures usually found above the commercial timber zone. The influences exerted on watershed conditions by the different forest types in this usually more arid belt are essentially similar.

Within this belt most of the precipitation comes in the form of snow, so that to the other run-off regulating influences of the forest is added retardation of snow melt. In contrast with conditions in the dense forests of the Pacific slope, the vegetative cover if once destroyed is likely to be slow in reclothing the soil, a condition that, as previously stated, favors accelerated erosion and run-off. The greater part of the area is used as range for livestock. This use easily upsets the vegetative balance, thus seriously reducing the effectiveness of the watershed cover. (Complete exclusion of livestock, however, is usually neither necessary nor desirable.)

These forests are the source of the greater part of the water flow for irrigation, water power, and domestic and industrial use in the West. Streams originating in them are, to a great extent, depended upon for the irrigation of nearly 20 million acres of land on irrigated farms which are valued including all land, buildings, and equipment at $4,887,000,000; for water-power developments that on January 1, 1931, were estimated to have an installed capacity of nearly 5 million horsepower or about 32 percent of the total installed capacity in the United States; and for industrial and domestic water supplies for about 6 million people. It is not an overstatement to say that the economic existence of the West is the measure of the importance of these waters.

Fortunately a very high percentage of the area is in national forests, national parks, and Indian reservations, where, as has been stated, something approaching proper watershed management is provided. Perhaps 3 million acres of it is in the public domain, where no management is provided other than inadequate fire protection and where watershed conditions are extremely bad.

Private ownership of this type of forest land is generally not favorable to good watershed conditions. A large proportion of these lands were acquired either as a land speculation or with the purpose of exploiting the virgin timber. The practice of industrial forestry on a permanent basis is the exception, and privately owned cut-over lands are not generally in a satisfactory condition. Too heavy cutting, unnecessary destruction of young growth in logging, fires in logging slash, and improper grazing use, have occurred too often.

In this belt tax delinquency on cut-over lands is exceptionally heavy, and the desire on the part of the owners to dispose of such lands is nearly universal. Many of the counties are financially unable to accept the responsibility of ownership of cut-over lands, and the States have shown little inclination to take over such lands. Existing conditions strongly encourage a greatly enlarged program of Federal acquisition of this type of land, as is shown in the section of this report entitled "Public Acquisition of Private Lands as an Aid to Private Forestry."

These forests are especially suited to multiple use. Timber cutting, grazing, recreation, and watershed use all have a definite place. There is urgent need for much carefully conducted research to develop the facts of proper management so that these various uses may be properly correlated.

SEMIARID WOODLANDS AND BRUSH LANDS

Throughout the West there is a belt usually below but sometimes intermingled with the commercial timber where, either because of the semiarid climate or of past treatment, the cover consists of scrubby timber or brush. This includes the chaparral and brush fields of California and the pinon-juniper, aspen brush, oak brush, and similar types. In these types the understory vegetation is generally sparse and is not easily maintained. The natural balance is finely drawn, and even slight changes in cover may give rise to an adverse watershed condition not easy to overcome. Annual precipitation is low, but individual storms are sometimes very intense. Snow storage on these areas is not heavy as a rule.

The major watershed problem is erosion, although floods and mud flows are locally important. These areas are most often the lower reaches of watersheds heading in the timber belt above, in which case the material eroded from them is fed into the stream channels from which water is obtained for irrigation, power, and domestic use. Less frequently, as in parts of southern California and of the Southwest, the woodland areas themselves are the main source of water for these uses.

Fire control is not particularly difficult except in California, although fires often are permitted to burn over large areas of brush fields. In parts of California, owing to steep slopes, the inflammable character of the brush, and the extreme drought conditions that normally occur during the summer season, fire is the major problem. Here torrential or merely heavy rains on areas denuded by fire result in heavy run-off and in great damage by floods and erosion. Where flood waters are spread out over settling areas for the purpose of raising the level from which water supplies can be obtained by pumping, fine eroded material tends to seal the soil in such a way as to make percolation difficult.

Almost all this area, with the exception of the dense brush fields of the south coast drainages of California, is used as range for livestock. Except on the national forests, national parks, and Indian reservations, the cover usually has been badly depleted through overgrazing and other improper range use and in some instances has been completely removed. The removal of the vegetation, the breaking up of the litter by trampling, and the mechanical disturbance of the top soil has brought about an increase in run-off and has resulted in serious erosion. The fertile top soil has washed away, leaving the land seriously reduced in productivity and much less retentive of rainfall. Floods are therefore common, silt is being sluiced into reservoirs and ditches, and in some instances such as that of the Salt Lake Valley and of southern California great damage to improved farms has resulted through the deposition of gravel and boulders carried by floods.

Owing to the semiarid climate, improvement of watershed conditions will be slow even under careful management. The mantle of humus and enriched top soil that is characteristic of a large part of this region is so thin as to be easily destroyed. The type of plant cover that these areas once supported depended in marked degree upon the high fertility of soil that has now been washed away.

A relatively small part of these lands is within national forests, national parks, and Indian reservations and a small additional area is being administered as city watersheds, particularly in southern California. Such areas are managed so as to maintain watershed values. The greater portion of these lands is in the public domain or in private ownership, and on this portion neither watershed nor range values are being maintained. Over large areas the quantity of forage produced now is less than half that originally produced.

The major step in correcting watershed conditions on these lands is extremely simple, yet in spite of at least two decades of pressure it has not yet been taken. The key to the solution is to place the public domain under proper administration. Proper management of public-domain lands together with the existing management of the national forests would encourage better management of privately owned range land and would therefore greatly improve conditions generally.

PROGRAM FOR ADEQUATE WATERSHED PROTECTION

LAND MANAGEMENT REQUIREMENTS

In order to meet the deficiencies in watershed protection that have just been presented the following major improvements in land management must be effected.

FIRE PROTECTION

Fire protection on watershed lands must be improved to meet the standards set up in the section of this report entitled "Protection Against Fire." This will mean giving organized protection to the 191 million acres of forest now unprotected and materially strenghtening protection on the units already organized. In particular, protection effort must be greatly strengthened in the South, the Central States, the Pacific Coast States, and parts of the Northern Rocky Mountain Region.

TIMBER CUTTING

Timber-cutting practice must be improved at least to the extent necessary to stop forest devastation. The requirements for the several forest types are set forth in the section entitled "How to Stop Forest Devastation." In general this will mean the adoption, to some degree, of the selective logging system. In many instances it will not decrease the profits of the operation. While this minimum requirement of forestry practice will not insure acceptable future timber yields, it will in most instances prevent erosion and have a measurable effect in establishing improved conditions of water flow.

REFORESTATION

Trees must be planted on 11 million acres of forest lands and submarginal agricultural lands where conditions are critical. This will lead not only to improved watershed conditions but to production of needed additional supplies of wood. Most of the lands that should be planted are now in private ownership. The program for planting is fully discussed in the section of this report entitled "Reforestation of Barren and Unproductive Land." Table 9 gives the approximate acreage that should be planted for watershed protection.

TABLE 9.—*Areas proposed for public acquisition, and areas requiring restoration of cover, for watershed protection*

Drainage	Areas to be acquired			Areas requiring restoration of cover	
	Submarginal agricultural land	Forested land	Total	To be reforested	To be otherwise revegetated
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
Northeastern	900	6,900	7,800	500	
South Atlantic	3,300	15,500	18,800	2,000	
East Gulf	4,600	15,400	20,000	1,000	
West Gulf	400	1,900	2,300	250	
Lower Mississippi	1,200	4,600	5,800	250	
Arkansas—Red	2,200	17,000	19,200	750	
Ohio Valley	6,000	22,600	28,600	4,000	
Upper Mississippi	2,500	4,600	7,100	500	
St. Lawrence	300	700	1,000	500	
Missouri	400	7,200	7,600	1,000	150
California		10,000	10,000	75	100
Colorado		2,800	2,800	150	200
Rio Grande		5,000	5,000	50	50
Great Basin		1,800	1,800	50	200
Columbia		12,400	12,400	150	200
Pacific Cascade		5,000	5,000	100	
Total	21,800	133,400	155,200	11,325	900

GRAZING MANAGEMENT

Grazing management must be improved, particularly on private lands, and must be introduced on public lands now unmanaged. On forest lands in the East (particularly farm woodlands) and range lands in the West (both private and unmanaged public) where improper grazing use has resulted and is resulting in widespread erosion and increased run-off, management practices must be applied that will not only stop deterioration but permit the vegetative cover to regain its original density and effectiveness. Artificial revegetation of some 900,000 acres at a cost of perhaps $3,000,000 seems to be desirable. Aside from watershed-protection requirements, such action is obviously essential to permanency of the livestock industry, particularly in the West. This subject is presented in detail in the section of this report entitled "A Forest Range Program."

SPECIAL MEASURES

On a limited area serious erosion now in progress can be checked only by special measures, frequently of an engineering character. These will include such measures as the installation of flumes at the head of active gullies, the construction of check dams, the scattering of brush, and the building of temporary retaining walls. Detailed estimates of the cost of such measures by regions have not been made, but such data as are available indicate the need for an expenditure of perhaps $20,000,000. In general such measures will be the first step toward the reclothing of the affected areas with a permanent cover of grass, brush, or trees.

REHABILITATION OF ABANDONED AGRICULTURAL LAND

Fully 70 percent of the erosion problem and 40 percent of the water-flow problem in the East result from improper agriculture. The remedy is (1) to improve agricultural methods so that erosion will be lessened and soil fertility maintained on supermarginal lands, and (2) to rehabilitate through forestry those submarginal lands which contribute to stream-flow and silting problems. Here we are concerned only with the latter. This will involve (1) fire protection to permit natural revegetation or reforestation where possible, (2) forest planting on land where erosion would otherwise continue, and (3) special measures where successful reforestation would otherwise be impossible because of soil movement.

RESEARCH

Exact experimental evidence upon which to base the management of watershed lands is far too meager, both here and abroad. The varied and complex influences of climate, forest type and condition, and character of soil on stream flow and on erosion must be carefully determined if forest-land management is to meet watershed-protection requirements. A conservative program that would meet this need is presented in the section of this report entitled "Research in the United States Forest Service, a Study in Objectives."

METHODS OF MEETING MANAGEMENT REQUIREMENTS ON PRIVATE LAND

The benefits to be derived from proper watershed management in large measure accrue to the public rather than to individual landowners. Except where conditions on the land constitute a demonstrable menace, corrective action should be financed, at least in large part, by the public rather than by the private owner. It has been shown that the greatest watershed problems exist on private land and unmanaged public land. Three avenues of approach are open to the private-land problem, each offering a different measure of promise.

COOPERATION

Public cooperation with private owners on a voluntary basis is the approach that has been followed in this country to date. By public financial aid the owner is encouraged to meet acceptable standards. That this method has failed is clear from the fact that today, after more than 20 years' effort, 46 percent of the private forest land is without organized fire protection and little more than 2 percent is handled in a way that promotes natural reproduction. In some States the private owners are indifferent to the need for fire protection. Private contributions in the West are almost exclusively for protection of virgin timber rather than for maintaining a satisfactory cover on cut-over land.

If satisfactory watershed management is to be had by this method, much, and perhaps most, of the cost of management will have to be borne by the public. Fire protection, except on virgin timberland, will be principally at public expense. Reforestation of large areas of devastated forest and submarginal farm lands will have to be undertaken or heavily subsidized by the public, and special measures, sometimes costly, will have to be taken, with little or no cost to the owner. Such action, without definite assurance that the land will be permanently managed in such a way as to protect the public investment, has little to recommend it.

REGULATION

Private ownership with public regulation of use is the second possible solution. This approach is common in European countries. The cost would be even heavier than under the cooperative plan. With land abandonment now common, it seems clear that the addition of any expense or of any restrictions on use would simply speed up this trend and result in much needless friction. Like all regulatory measures, this system would depend for its success on public sentiment. Past experiences do not permit optimism with regard to the functioning of unpopular legislation. Regulatory forest laws have been enacted by most of the States, but they do not have adequate public support and have not in general been effectively enforced.

PUBLIC OWNERSHIP

Public ownership and management of major-influence forest land that can be blocked up for satisfactory administration and of agricultural land highly subject to erosion is the third possibility. Obviously it is unnecessary to propose public ownership of land in these classifications that, because of timber or other values, will be managed reasonably well in private ownership. This method would accomplish by direct action what the alternative methods would attempt to bring about through indirection. Under this method the public would of course pay all the cost of management and protection; it would receive, however, not only the benefit of improved watersheds but the more tangible benefits accruing through sale of forest and range products. In the long run the projects would be self-liquidating.

Public acquisition of major-influence watershed lands appears to be the most logical solution. Present trends indicate that the cost per acre would be low. Federal, State, county, and municipal governments should proceed with the acquisition of such lands as rapidly as such programs can be financed. Table 9 presents, by major drainage regions, the program that on the basis of present information appears advisable.

BRINGING UNMANAGED PUBLIC LAND UNDER SUITABLE MANAGEMENT

On public watershed land now unmanaged the public should redeem the obligations of ownership by instituting management of the type recommended in the foregoing. The public domain is the outstanding example of unmanaged Federal lands. The first step in the direction of bringing public-domain watersheds under management would be approval of legislation authorizing the public administration of these lands substantially as recommended in the section of this report entitled, "Public Domain and Other Federal Forest Land."

State and county land now unmanaged should be placed under management as rapidly as possible, although this action will not always be easy. Large aggregate areas are coming into State and county ownership as small tracts of devastated forest or submarginal agricultural land. Comprehensive planning is needed to work out the most feasible division of responsibility and methods of administration. To block the areas up into administrative units would require the purchase of additional lands and exchange of ownership among various public agencies including the Federal Government.

A FOREST RANGE PROGRAM

By W. R. Chapline, Chief, Division of Range Research, and R. S. Campbell, Associate Forest Ecologist, Southwestern Forest and Range Experiment Station

CONTENTS

Page
Western forest ranges 1537
  The unreserved public domain 1538
  State forest ranges 1538
  Private forest ranges 1538
  Existing Federal reservations 1539
Southern forest ranges 1539
Farm woodlands 1540
Research 1540

The "Forest Ranges" section of this report points out that 334 million acres, or 54 percent, of the forest land in the United States is used for grazing domestic livestock, and presents the problems involved in coordinating the use of forage with conservation and use of other forest resources. The need for management that will assure sustained yield of forest ranges is shown by the poor condition of much of the forest-range area of the West, the extreme and continuing deterioration of forage and watershed-protective values on most public-domain forest lands and on a considerable part of the private forest lands in the West that are grazed, the damage to timber production in the South resulting from uncontrolled burning of forest lands in an effort to improve range conditions, and the deterioration of some farm woodlands as a result of heavy browsing of tree sprouts. The management of these lands should be such as to perpetuate their range and other values, to afford sustained use of the forage by livestock, and to effect the economic and social benefits that would result from stabilizing the use of the lands. Sustained yield management of forest ranges involves: (1) Correlation of the use of the lands by domestic livestock with the conservation and use of other resources such as watershed protection, timber, recreation, and wild life; (2) reservation, consolidation, and administration of public lands now inadequately managed; (3) public acquisition for administration of certain areas at present in private ownership; and (4) research to develop principles of management.

The forest range management program deals with three distinct situations, those of the western forest ranges, the southern forest ranges, and the farm woodlands.

WESTERN FOREST RANGES

Public interests are vitally affected by the management of forest ranges in the West. The present productivity of the herbaceous and shrubby vegetation, falling far short of the potential productivity on many areas, does not furnish as satisfactory livestock production as possible, and thus limits the prosperity of the livestock industry and communities dependent upon it. Watershed-protective values of grazed forest ranges would be improved by increased vegetative cover. On some areas overgrazing or other improper grazing use is impairing the perpetuation of timber and wild-life resources.

THE UNRESERVED PUBLIC DOMAIN

Outstanding among the problems presented by the 102 million acres of publicly owned or managed forest range land in the West are those that have arisen on the public domain, as a result of use without administration. Grazed lands make up 21.5 million acres of the 23 million acres of forest land now remaining in the public domain. There is urgent need for legislation placing these lands under a type of administration that will stop abuse, restore values, and stabilize grazing use for local community and other public benefit. As is shown in the "Other Federal Forest Land" section of this report, approximately 19 million acres of the public domain, including 11.5 million acres of forested land, should be added to the national forests. About 3 million acres additional, of which 1.5 million acres is forest land, should be given national-forest status and held for inclusion in new administrative units as these are built up by acquisition or exchange. The remaining public domain, including approximately 10 million acres of forested land, should be placed under Federal administration that will assure satisfactory management.

STATE FOREST RANGES

On most State-owned forest ranges, other than those that are now handled under cooperative agreement with the Forest Service, better coordination of grazing with other forest uses is necessary. This would best be effected by consolidating as much as possible of the 4 million acres of grazed forest lands in State ownership into State forests or other administrative units with a legal status insuring sustained-yield management. On forested State lands that cannot effectively be grouped into administrative units, it is essential that leases include specifications as to numbers of stock to be admitted, seasons of use, and other phases of management, and that field supervision be provided, in order to prevent overgrazing and assure range restoration where it is needed.

PRIVATE FOREST RANGES

Of the 64 million acres of private forest land in the West approximately 42 million acres is grazed. On a high percentage of this area the effort to gain the maximum current income has been carried to an extreme without adequate safeguards for permanent stability of the range resource. This has resulted in range depletion that not only adversely affects the individual stockman but also is doing damage to others, especially through impairing watershed-protective values. Where it is demonstrated to stockmen using these private lands that by modifying their present practices they can correct existing damage to forest range resources without material loss of revenue or with an eventual increase in revenue, better management of the ranges can reasonably be expected. Western agricultural extension services could very well give a greater place on their educational and demonstrational programs to improved principles of range management.

In the case of critical areas, public ownership and management will probably be the only effective solution. In the section of this report entitled "The Probable Future Distribution of Forest Land Ownership", it is recommended that 41 million acres of forest land in the West having a major watershed-protection influence be purchased or otherwise acquired from private owners and administered by public agencies to assure satisfactory watershed protection. Probably two thirds of this area proposed for public acquisition is grazed.

A small additional area of private forest range land should be acquired by the public by purchase or exchange in order to consolidate existing units of publicly owned land and thus facilitate their proper management.

EXISTING FEDERAL RESERVATIONS

About 64 million acres, or nearly two thirds, of the publicly owned or managed forest range lands in the West is within the national forests. The administrative aim on the national forests, of obtaining as fully beneficial use of the various resources of the land as is consistent with their permanent conservation, has resulted, on the average, in a marked improvement of forage conditions. This in turn has tended to stabilize livestock production on national forests and to furnish an improvement in watershed-protective values and in conditions favorable for wild life. Such administration should be continued and management should be improved as research results and more accurate information concerning the grazing resource become available. Development of range improvements such as fences and watering places should progress steadily. About 90 percent of the 900,000 acres of western forest land recommended for artificial revegetation in the section of this report entitled "A Watershed Protection Program" is within the national forests. In addition to this area on which artificial reseeding could be applied on the basis of present knowledge, there are very large acreages within the national forests and elsewhere, particularly at the lower elevations, on which artificial reseeding is desirable but will require further research.

Within the Indian reservations, on which the aim is to obtain maximum benefit for the Indians, there is need for an intensification of field administration and management, as outlined by Muck, Melis, and Nyce,[1] with special emphasis upon sustained forage production and effective protection of forest-land resources.

The area of grazed forest land in other Federal reservations is relatively small. On most of it, grazing is administered in such a manner as to have the least possible influence on the major use of the area. Within the national parks, for example, grazing, where still permitted, is subordinated to recreational and inspirational values.

SOUTHERN FOREST RANGES

In the South the forest range problem at the present time is almost entirely restricted to privately owned land; nearly 98 percent of the southern forest area grazed by domestic livestock is in private ownership. As public agencies continue to acquire forest land, administration of public lands will become more prominent. A program that will safeguard timber and other forest values and aid in livestock production includes: (1) Control of fire; (2) control of grazing by hogs, especially in the longleaf pine belt; and (3) coordination of forest range use with use of improved pastures and of forage crops on farms.

---

[1] Muck, Lee, Melis, P. E., and Nyce, G. M. An Economic Survey of the Range Resources and Grazing Activities on Indian Reservations. Hearings before a Subcommittee of the Committee on Indian Affairs, United States Senate, Seventy-first Congress, Second Session. S.Res. 79, 308 (70th Cong.), and S.Res. 263 and 416 (71st Cong.), 1932.

This program would be advanced by ultimate Federal acquisition of about 78 million acres and State acquisition of 19½ million acres of private land in the South for timber production and watershed protection, recommended in the section of this report entitled "The Probable Future Distribution of Forest Land Ownership." In many of the southern States legislative provision would be necessary for the organization of these lands into State forests and for their administration and management. On forest land remaining in private ownership, education and demonstration will be the principal means of correcting practices detrimental to timber production and obtaining coordination of the use of forest lands with that of agricultural lands to assure the most beneficial use of all the feed resources. In some States, for satisfactory timber production, legislation may be required to prevent trespass on large private forest holdings.

FARM WOODLANDS

The greater portion of the grazed farm woodlands in the Central States, Lake States, Middle Atlantic, and New England regions will remain in private ownership. In these regions the individual owner should decide what is the most profitable use of his farm woodland and, accordingly either exclude livestock, admit livestock to a small portion of the woodland for shade but exclude it from the remainder, or admit livestock to the area only for such a period and in such numbers as will permit sustained yield of timber and forage. Safeguarding forest regeneration and other forest values will require research and education.

In these regions grazing on public forest lands is ordinarily light. It is probable that grazing use will be light on many of the forest areas acquired by public agencies for watershed protection or timber production. Feed resources on farm land are so abundant and grazing values on forest lands so low that use of public forest land by domestic livestock should be restricted to such areas as can be grazed without detriment to other forest values.

RESEARCH

Experience and the comparatively small amount of research done to date have developed many improved practices in the use of forest range lands, which make for greater stability in use and for increased revenues to offset any increase in production costs resulting from increased settlement, range deterioration, and more intensive management. Much still needs to be learned with respect to coordinating the use of forest range forage with the conservation and use of other resources and with respect to utilizing the important forage plants in a manner that avoids danger of deterioration and tends to improve depleted forage cover.

In plans for research bearing on the management of forest range lands, emphasis should be placed on breaking down the broader problems of plant succession, soil productivity, physiological response to use, genetic development of range plants, biological relationships, etc., into factors that can be studied and evaluated in an exact way. In order to meet current problems of management, the more immediately practical studies, which have largely characterized the work to date, should be continued. Studies of forest range restoration should consider both the possibilities of restoring and maintaining the stand of native forage plants and the possibilities of artificially reseeding areas where natural restoration of native plants would require a very long period. Many economic phases of use of forest ranges and of profitable production of livestock on such ranges will need to be studied intensively and continuously if ever-changing economic conditions are to be met.

A considerable expansion of the range-research program of Federal and State agencies is well warranted. In the section of this report entitled "Research in the United States Forest Service, a Study in Objectives", a 10-year program for financing research is set up, including the last four years (1935–38 inclusive) of the decade provided for originally by the McSweeney-McNary Act and an additional six years ending with the fiscal year 1944. This 10-year program recommends that appropriations for the range investigations of the Forest Service be increased by an average of $40,000 a year up to 1938, in order to meet the McSweeney-McNary Act authorizations of $275,000 yearly. For the period 1939 to 1944, inclusive, it recommends annual increases averaging $50,000. There is not much doubt that at the end of this 10-year period there will still be need to expand the research program.

A PROGRAM FOR FOREST RECREATION

By Robert Marshall, Collaborator

CONTENTS

Page
Recreational survey 1543
Program for specific types of recreational area 1544
Legislation required 1546
Area needed primarily for recreation 1546

RECREATIONAL SURVEY

The use of the forest for recreation has received such entirely inadequate study that the first recommendation of a realistic program should be for a careful survey of forest recreational requirements. Such a survey should consider (1) what type of forest recreation the people particularly desire and (2) how much forest land should be set aside exclusively for each of the different types of forest recreation.

The first study might be made by questionnaire and by a careful check of the use of existing recreational facilities. Some specially planned investigations are needed also, for example, as to whether most forest recreationalists care what sort of timber is available to them. This question might be investigated by laying out three camp sites in some particular locality, all similar in every way except that one would be on an area seriously damaged by logging, one on a well-managed cut-over tract, and one in an old-growth forest. By checking the attendance at the three camp sites it might be possible to obtain a very good notion of the preferences of forest visitors.

Such subjects might be studied by many agencies. They would be excellently adapted to investigation by the sociology departments of certain universities. The National Park Service, the Forest Service, and several State park services are very favorably situated for such investigations owing to their actual administration of recreational land. The various conservation societies would be logical agencies to pursue such investigations.

The survey of the area required for recreation should be undertaken by some committee which would represent the chief agencies administering recreational lands and the chief points of view of those who use the forest for recreation. Such a survey is needed immediately, for every year sees many tracts among the most precious types of recreational land eliminated as recreational possibilities. The organization of a forest-recreation committee should not interfere with the surveys which the National Park Service, the Forest Service, and the various State park services are already undertaking. It should simply coordinate the activities of these agencies. Such coordination is essential for the reason that the forest-recreation problem in America is not confined to any one form of land administration. The points of view both of the administrators of American forests and of those for whose benefit the forests are being administered should have representation in working out a satisfactory policy.

PROGRAM FOR SPECIFIC TYPES OF RECREATIONAL AREAS

It is important to consider, for each of the important types of recreational land discussed in the section on The Forest for Recreation, what action within the next few years seems desirable.

SUPERLATIVE AREAS

(Localities with unique scenic values, so surpassing and stupendous in their beauty as to affect almost everyone who sees them)

(1) A thorough survey of the entire country to find any forest areas of superlative scenic value which may not now be adequately protected as national parks, national forests, and State parks.

(2) Setting aside as national parks, national forests, or State parks of any such areas thus discovered.

(3) Educating the public into an appreciation of the proper use of superlative areas. This is a function of both public and private organizations.

PRIMEVAL AREAS

(Tracts of old-growth timber in which human activities have never upset the normal processes of nature)

(4) An immediate organized survey to find adequate areas of old-growth timber in each important forest type which might be devoted to recreational enjoyment.

(5) Setting aside from all commodity exploitation those desirable primeval areas which the survey indicates are already included in public lands.

(6) Public purchase or acceptance as gifts of those tracts at present in private ownership which should be reserved as primeval areas. Purchase by the Federal Government may generally be preferable to purchase by the States or counties, because forest types are not confined by State boundaries. In many cases, also, there is greater stability to Federal forest policy. Further, if we are to retain a museum of the finest manifestations of each important forest type, such a museum will certainly be of national and not merely local interest.

(7) Continuation of studies already begun as to the effect of various degrees of use on the biological well-being of primeval areas.

(8) Construction of trails which most visitors will automatically follow instead of wandering promiscuously and trampling down soil and vegetation throughout the tract.

WILDERNESS AREAS

(Regions which contain no permanent inhabitants, possess no means of mechanical conveyance, and are sufficiently spacious that a person may spend at least a week or two of travel in them without crossing his own tracks)

(9) Consideration of the desirability of establishing as wilderness areas those large tracts on the national forests and the Indian reservations which have not yet been dissected by roads, but which have not thus far been reserved as wilderness areas.

(10) Consideration of the suitability of the Okefenokee Swamp as a wilderness area and the practicability of its public purchase.

(11) Consideration by the State of Maine of the desirability of obtaining easements from the private owners of the four Maine wilderness areas barring the construction of roads through these areas.

(12) Legal sanction for barring airplanes from wilderness areas except in case of forest fire or other emergency.

(13) Education of the public, largely through the efforts of private organizations, into an appreciation of the values and understanding of the necessary technique of wilderness journeying.

ROADSIDE AREAS

(Timbered strips adjoining the more important roads)

(14) A survey of the areas necessary to preserve the scenic value of State highways and of the more used local roads.

(15) Contracts between the various States and private landowners in which, either with or without a monetary consideration, the owners agree that they will not make any cuttings on the roadside strips, that they will not otherwise mar or deface their beauty, and that they will refrain from erecting houses upon them except with the approval of some duly designated State authority.

(16) When such contracts cannot be made, the roadside areas in private ownership should be purchased by the States. In cases where roadside strip borders important approaches to Federal recreational land the National Government will be justified in making these purchases.

(17) Elimination from the roadside strips of all billboards and such buildings as seriously interfere with scenic values.

(18) Planting to increase the beauty of the roadside areas.

(19) Construction of new scenic roads, on principles of sound landscape architecture, where they do not injure superlative, primeval, or wilderness areas.

CAMP-SITE AREAS

(Forest land set aside for camping)

(20) A survey of the number of camp-sites needed in different regions to meet the requirements of overnight campers. Such a survey must be made with special reference to the distribution of population. In general each important population center will have to work out its own program, but the different programs will require some central coordination.

(21) Establishment of the desirable camp-site areas, usually by local communities or States, according to carefully worked out plans.

(22) Enforcement of the necessary regulations for the administration of camp-site areas.

(23) Education of the public in regard to good camping manners.

RESIDENCE AREAS

(Forest land set aside for private homes, hotels, resorts, group camps, sanitoria, and stores and services of one sort or another)

(24) Careful planning for Government owned areas, and the elimination of any unsatisfactory developments on existing areas.

(25) Education of private owners of residence areas in regard to the proper development of such areas. This education may be provided both by the public and by private conservation organizations.

(26) Elimination of objectionable private developments, by the State police power when possible.

OUTING AREAS

(Tracts of land on which one can get away from the sounds of the highway and which have not been severely injured scenically)

(27) Determination of what fraction of the area required for ordinary forest outings may be managed at the same time for timber production and what fraction is likely to receive such heavy recreational use that it cannot be allowed to receive, even for a few decades, the scenic injury which the very best forestry practice generally brings for at least a limited period.

(28) Special reservation of those public lands which cannot be spared from recreational use for even a fraction of a rotation.

(29) Public purchase or acceptance as gifts of those private lands which cannot be spared from recreational use for even a fraction of a rotation.

(30) The practice of sustained-yield forestry on the bulk of the forest lands which will be available for both commodity production and recreational use if their productivity is maintained.

(31) Construction of roads to make new outing areas readily accessible to the public.

(32) Trail developments to obtain the maximum use from the outing areas.

LEGISLATION REQUIRED

(1) Appropriations by Federal, State, and local governments for purchase of lands now in private ownership which are needed to round out recreational holdings.

(2) Appropriations by Federal, State, and local governments for development and regulation of camp-site areas.

(3) Adequate appropriations to protect the recreational areas from serious injury by fire, insects, and fungi.

(4) Special authorization by Congress of the use of funds for developing and safeguarding the recreational, educational, and inspirational values of the national forests.

(5) Congressional sanction for barring airplanes from Federal wilderness areas.

AREA NEEDED PRIMARILY FOR RECREATION

The area which will probably be needed primarily for forest recreation may be roughly summarized as follows:

	Acres
Superlative areas	3, 000, 000
Primeval areas	9, 500, 000
Wilderness areas	10, 000, 000
Roadside areas	4, 000, 000
Camp-site areas	1, 500, 000
Residence areas	6, 000, 000
Outing areas	11, 000, 000
Total	45, 000, 000

Already 11 million of these 45 million acres have been withdrawn from timber use, leaving 34 million acres still to be reserved.

A FOREST WILD-LIFE PROGRAM [1]

By Paul H. Roberts, Administrative Officer Branch of Research, in cooperation with the United States Biological Survey

CONTENTS

Page
Objectives 1547
Requirements to meet the objectives 1548
  Wild-life management 1548
  Unification of wild-life and forest-land management 1548
  Provision for public hunting grounds 1550
  Provision of adequate areas for wild life 1551
  Establishment of State game commissions 1553
  Wilf-life research 1553
  Education 1554

The social and economic values inherent in wild life on forest land directly affect the national welfare and that of local communities as previously discussed in the section Wild Life a Forest Resource. Such values fully justify a program that will ensure the fullest development and proper use of the wild life resources consistent with the development and proper use of other resources and uses of forest lands. The first step in the formulation of such a program should be the determination of the primary objectives.

OBJECTIVES

(1) The principal objective of a wild-life program on forest lands is to obtain the best development and use of wild life as a product and a service of the land. This includes the development of the full economic potentialities of wild life in proper coordination with other resources and products of forest land. The movement to accomplish this is now only in its initial stages. Results so far obtained strongly indicate that wild life, principally game and fur bearers, will under proper management yield a fair return; that it will ease the financial burden incident to the private ownership of forest lands and particularly of those having low productive values; and that it will materially increase the services from publicly owned lands. Involved in this principal objective are a second and a third.

(2) The predominant use of the wild-life resource is for aesthetic, scientific, and other social purposes, hunting excepted. This objective contemplates the adequate protection of American animals and birds, the maintenance of a proper and in so far as possible a natural balance between the forest vegetation and the forest wild life. Many who use the forest for recreational or scientific purposes do not care to hunt, but the forest for such purposes is incomplete without its wild-life complement.

(3) The traditional and possibly the most generally accepted objective of wild-life management is the preservation to the American

---

[1] The program affecting birds and mammals is discussed here. The program and requirements affecting fish life are covered in a preceding section, entitled "Wild Life a Forest Resource".

people of the privileges of the hunt, and the social benefits to be derived therefrom. It involves the question of maintaining public shooting grounds or public wild-life areas for those who can not afford private shooting or private estates. It involves the maintenance and use of the wild-life resource for all hunting purposes and for all people. It contemplates the preservation of an American ideal.

(4) The preceding objectives presuppose a fourth—the education of the general public in the recognition of wild-life values and the importance of their proper management. Interest in wild life has heretofore centered largely among sportsmen and wild-life enthusiasts and their organizations, and around social values. There should be a more wide-spread public recognition of all the values of wild life as a forest or other land resource.

REQUIREMENTS TO MEET THE OBJECTIVES

The second step in the formulation of a wild life program for forest lands is the determination of the requirements necessary to meet the objectives named.

WILD-LIFE MANAGEMENT

Wild-life management, particularly of game species and fur bearers, is the first essential in the development of wild-life as a forest-land resource. Only through sound and comprehensive management can the maximum social and economic benefits from wild-life accrue. Serious diminution and depletion of wild-life values have resulted from lack of widespread and proper management of the resource.

The reduced game and fur supplies in many parts of the country, the depletion of quail nearly throughout its range, of prairie chicken in the plains country, and deer and grouse in many States and localities is due primarily to lack of wild-life management.

Management of wild life in broad terms includes its restoration, protection, propagation, care, and regulation of use. The chief distinct problems that wild-life management must meet are:

(1) Restoration and development of game, fur bearers, and other wild life in the Central, Lake, South, and parts of other regions of the East.

(2) Restoration of wild life on areas where depletion has occurred in the West and development of the resource on all forest lands of the West.

(3) Preservation of species now threatened with extinction for scientific and other reasons.

(4) Widespread distribution of game and other wild life and, in so far as environmental conditions will permit, distribution of species to afford hunting and to meet the demands of those classes of people who enjoy other aspects of wild life.

(5) Proper biological balance between species.

(6) A sustained yield of the wild-life crop, particularly game and fur bearers.

UNIFICATION OF WILD-LIFE AND FOREST-LAND MANAGEMENT

Unification of wild-life and forest-land management is the second essential requirement of a wild-life program. Wild-life management is only one phase of broad forest-land management and accordingly must be correlated with the management of other products and services such as timber, forage, watershed protection, and recreation, and with the management of the land itself. Land management, for example, must provide the natural food, cover, protection, and other environmental conditions upon which wild life is dependent.

Unification of wild-life and forest-land management is made difficult by the fact that in general the control of game is in the State, while the ownership and control of land may be private, State, or Federal. In this respect it differs from most if not all other products, the ownership and control of which go with the land. This situation creates three rather distinct problems depending upon the ownership of the forest land:

(1) On privately owned lands, control of game by the State without unification of game and land management has resulted in lack of consideration of game values and requirements in the handling of much private land. This has led to game depletion by destroying proper environmental conditions for game in some regions by overgrazing and fire. The landholder has had little direct interest in game as a land resource, has not had control over it, and hence in many cases has in great measure failed to provide the conditions necessary for its maintenance or development. He is, however, in the best position to provide the proper environmental conditions. The problem is to develop ways and means of inducing him to do so.

The American game policy proposed by the American Game Association at the seventeenth annual game conference in December 1930, states with respect to the private landholder:

> Only the landholder can practice management efficiently, because he is the only person who resides on the land and has complete authority over it. All others are absentees. Absentees can provide the essentials; protection, cover, and food, but only with the landholder's cooperation, and at a higher cost.
>
> With rare exceptions, the landholder is not yet practicing management. There are three ways to induce him to do so:
>
> 1. Buy him out, and become the landowner.
> 2. Compensate him directly or indirectly for producing a game crop and for the privilege of harvesting it.
> 3. Cede him the title to the game, so that he will own it and can buy and sell it just as he owns, buys, and sells his poultry.
>
> The first way is feasible on cheap lands, but prohibitive elsewhere. The second is feasible anywhere. The third way is the English system, and incompatible with American tradition and thought.

Despite the fact that the second way of inducing the private landholder to practice game management seems the most feasible method of meeting the requirement for unified game and land management on private lands, there are some difficulties in carrying it out. The individual landholder, except possibly in minor instances, can not manage and control game incident to his control of the land. Game is too mobile and individual holdings are often too small in area to afford satisfactory units of management. Under such conditions the solution appears to be in cooperative arrangements between groups of individual landholders and the States, which will provide for the grouping of lands for wild-life management for a common purpose, contributing toward the best utilization of all the land resources. The return to the landholders is through the medium of fees, which may be charged for shooting on their land.

This phase of the problem centers primarily in the East where 85.6 percent of the forest land is in private ownership, as contrasted with

14.4 percent in the West. Experimental projects of this kind are now under way. Impetus should be given to the rapid development of ways of meeting the situation on a broad scale.

(2) On State lands, ownership and control of both game and land should provide an excellent opportunity for unified management. Even here, however, the control and management of the game may be in one State department and the management of State lands in one or more other departments. In certain instances where wild life and other forest-land resources are administered by separate State agencies, the two are in direct competition in the independent acquisition of lands of the same general character, and one or the other, because of greater activity, aggressiveness, or public interest, may be forging ahead. Sound land management would dictate a coordination of objectives and a unification of interests if wild life and other land-resource management are to attain desired results within the State.

(3) On Federal lands, the Federal Government has an interest in the development of the game resource as well as in the development of other resources and uses. Without the same control of game as of other resources, it must in general depend on cooperation with the States in working out measures of benefit not only to game but to other resources, uses, and services of forest land affected by game; for example, timber, forage, watershed protection, and recreation. This is especially true of the national forests which embrace 140 million acres in 31 different States, and are in practically every instance multiple-use forest units.

The working out of satisfactory arrangements with the State constitutes one of the important problems in the correlation of wild life and other land management on the national forests and most other Federally administered forest lands. Correlation of game and land management on national-forest lands in cooperation with a State is exemplified on the Pisgah National Game Preserve in North Carolina where the value of game preserves and need of game management as a demonstration of what might be done on similar areas early resulted in the State ceding jurisdiction of game to the Federal Government and later approving the plans developed for the area.

PROVISION FOR PUBLIC HUNTING GROUNDS

The third requirement in a wild-life program for forest lands is adequate provision for public hunting grounds. One of the best established and most ingrained American traditions is that of the privilege of the hunt. In earlier days public lands covered a vast expanse, wild life was abundant, and the privilege was open to all who would make use of it. With the passing of public lands into private ownership, accompanied by diminishing game supply, restriction of areas available for public shooting was inevitable. Today in the East, with more than nine tenths of the forest land in private ownership, and with closure of great tracts of this area to public shooting, open lands available for those who enjoy the sport and who reap accompanying benefits are entirely inadequate to meet demands.

With increasing restriction of shooting on private land, public shooting grounds are becoming increasingly essential if hunting is to be available to the rank and file and this social value of game is to be realized. Thorough fact finding and analysis is required to determine the true situation in various regions. It is a matter which should be kept definitely in the foreground if the greatest public benefits are to be derived from the game resource.

Senate Resolution No. 175 specifically mentions among other things leased hunting and fishing rights, the development of which would afford valuable resources for recreation, and improvement in national health, besides giving wealth producing and steady employment to a large number of persons, etc. However, although there can be no question about the leasing of private lands if not contrary to the laws of the States in which the land is located (as discussed in the section "Wild Life a Forest Resource"), the leasing of public lands is of doubtful value. There are no instances available of existing leases on Federal, State, or other publicly owned or controlled land, for such purposes as would furnish the basis for sound judgment as to the probable benefits of such action. It is believed, however, that the objectionable features of a leasing system on public land outweigh any possible financial benefits, that it is not consistent with the best use and development of the game resources for public benefit, and that funds needed for development of the game resource and land management can be obtained more effectively in other ways. It should be possible adequately to meet the costs of such management through the medium of hunting and fishing license fees, the income from which should be sufficient to cover the costs of correlated land management in so far as the wild-life resource is concerned. In the East the provision for public hunting grounds should be an important consideration in any plans of forest-land acquisition.

PROVISION OF ADEQUATE AREAS FOR WILD LIFE

The fourth requirement in a wild-life program involves the forest land itself. It includes adequate area of such lands to provide for: (1) General forest habitat requirements of wild-life species, (2) public shooting grounds, already discussed, (3) special wild-life areas for specific purposes of protection or management, (4) areas devoted to the preservation of wild-life species, (5) areas for all purposes of wild life in parks and zoological gardens. In addition, adequate areas of nonforest land are needed as winter range in order to permit the fullest proper development of the wild-life resource on some forest lands.

All forest lands are usable by one or more wild-life species of social or economic importance. Accordingly any area that is devoted to forestry in the future can be used for wild-life production.

Forest and other land-area requirements of wild life are closely associated with ownership and control of land between the broad classes of Federal, State, and private. One of the broad problems surrounding land rquirements for wild life, therefore, is to meet such requirements for the most part under existing and future conditions of tenure, in a way to accomplish satisfactory progress in meeting wild-life objectives.

ON PRIVATELY OWNED AREAS

Privately owned forest lands amount to 444 million acres, or 72 percent of the total of 615 million acres of forest land in the United States. Of this total 150 million acres or 24 percent of all forest land is in farm woodlands, and 294 million acres or 48 percent is in other private holding.

In the East private ownership comprises about 95 percent of the forest area at present and must therefore be depended upon to a corresponding degree to support wild life. Game birds such as quail, grouse, and pheasants, insectivorous birds, and small game animals, particularly rabbits, are readily sheltered in farm woods and other private holdings. The larger private holdings meet to a considerable degree the requirements for the large game animals, and here the demand for lease or purchase of hunting privileges may be largely met. Where public lands are very limited, it may be possible for the State, through lease or other control of these privately owned forests to establish public hunting grounds, to reserve areas for scientific study, or to arrange for public recreation grounds.

In the West, privately owned forest lands amount to 63,935,000 acres or 30 percent of a total forest land area of 214,082,000 acres. Together with public lands they will meet the general forest-land requirements for wild life.

ON STATE, COUNTY, AND MUNICIPAL FOREST LANDS

The 17,421,000 acres of State, county, and municipal forest lands in the United States—10,912,000 acres is in the East, and 6,568,000 in the West—forms so small percentage of the total forested area as to be relatively unimportant in meeting general forest-habitat requirements of game. However, requirements for wild life in parks and zoological gardens can be met almost entirely on such forest lands. State and county forest lands will also aid materially in meeting total area requirements for special wild life purposes. State and county holdings are now insufficient to provide adequate areas to meet demands for public hunting grounds. Present areas should be used to the fullest possible extent for this purpose and the question should also receive consideration in the management of future enlargements of State and county forest land areas.

ON FEDERALLY OWNED OR CONTROLLED LANDS

Federally owned or controlled forest lands, comprising an area of 152,721,000 acres or about 25 percent of the total forest land area of the United States—143,579,000 acres is in the West, and 9,142,000 acres in the East—are of material importance in fulfilling general forest land requirements of game.

In the West federally owned or controlled lands are adequate for the best development of the wild-life resources; they supply public hunting grounds for all game with the exception of migratory birds; and they meet special wild-life needs, supplying areas to be devoted to the preservation of wild-life species, to wild-life development projects, and to the promotion of aesthetic enjoyment of wild life as in national parks and monuments.

The 26,311,000 acres now used in meeting special needs of wild life is doubtless, subject to adjustments as to location in some cases, sufficient to meet the requirements.

In the East, Federal lands form so small a percentage of the total forest land area as to be incapable of fulfilling area requirements for wild-life on anything like the extensive scale possible in the West, and additional areas are desirable. Extensive areas are, however, extremely important in meeting in part public hunting ground requirements as well as requirements for special purposes.

Federally owned nonforest lands, in the West particularly should assist in meeting requirements for winter range. There are no satisfactory estimates of the total area needed for this purpose. It would undoubtedly in the aggregate amount to many millions of acres.

ESTABLISHMENT OF STATE GAME COMMISSIONS

The fifth requirement is the establishment in all the States of active, nonpolitical State Game Commissions, having full authority to regulate seasons, bag limits, license fees, closed areas for any purpose, and other phases of game and wild-life management. This would be of material benefit to nation-wide wild-life conservation. In general there is too little effective effort devoted to wild life conservation. Regulation of hunting, prevention of trespass, supervision and patrol of areas closed to hunting, and other measures necessary for wild-life administration are entirely inadequate.

WILD-LIFE RESEARCH

Basic wild-life research as the foundation of management and administration is of fundamental importance as a sixth requirement in a wild-life program for forest lands. The United States Biological Survey under the McSweeney-McNary Act (45 Stat. 699) is carrying on such research regarding the interrelationships of wild life species especially rodents, predacious animals, game animals, fur animals, birds, reptiles, and amphibians. The present program of research includes relationship of game to other forest-land resources, including breeding and feeding habits, maintenance of numbers and harvesting surplus, wild-life values, and many other phases of wild-life biology. Present work should be expanded by bringing the appropriations for this purpose up to the amount authorized by 1938 and by such additional amounts thereafter as may be needed.

The Federal Government through its Biological Survey should be in a position to furnish fundamental facts about wild life to its own units concerned with land management, and to aid the several States in the development of their wild-life resources. This is particularly necessary at this time when acute problems present themselves with respect to making wild lands pay their way, and in the rehabilitation of impoverished areas of constantly increasing size and economic burden.

Several States, notably California, Massachusetts, Michigan, New York, Pennsylvania, and Wisconsin, through their conservation commissions, game departments, or educational institutions, are conducting important studies of various wild-life problems. Private industry has also conducted far-reaching investigations. Notable examples are the Sporting Arms and Ammunition Manufacturers Institute, and the E. I. du Pont de Nemours & Co., Inc. Work of this character, both by State and other institutions and private industry, should be expanded as rapidly as funds can be made available.

EDUCATION

Public education is necessary as a seventh requirement to obtain a general recognition of the values of wild life as a forest-land resource and in accomplishing other objectives of a wild-life program. Lack of sportsmanship in adhering to bag limits, in observance of closed seasons, and in opposing efforts to impose necessary restrictions as to methods of taking and other regulatory measures designed to protect game birds and animals and other wild life, is in many instances due to lack of a real appreciation of game and other wild-life values. Adequate protection from the "poacher", the "sooner", and the "game hog" cannot be entirely achieved by State or Federal enforcement. When the landowner realizes the values in the game on his lands and gets a return therefrom, he will become an important part of the game development and protection forces.

A PROGRAM FOR FOREST RESEARCH

By E. H. FROTHINGHAM, Director Appalachian Forest Experiment Station

CONTENTS

Page
Forest research by Federal agencies 1555
  Forest Service research 1556
  Research in forest pathology by the Bureau of Plant Industry 1565
  Research in forest entomology by the Bureau of Entomology 1565
  Research in naval stores by the Bureau of Chemistry and Soils 1566
  Research in forest biology by the Biological Survey 1566
  Fishery research in forest waters by the Bureau of Fisheries 1567
  Forest fire weather research by the Weather Bureau 1568
  Forest research possibilities of the National Arboretum 1568
Forest research by the States 1569
Forest research by quasi-public and private agencies 1571

Other sections of this report have discussed the character and cost of the forest research now being conducted by public and private agencies in the United States. The purpose of the present section is to bring together these different fields of research activity so as to permit a view of the size and nature of each in relation to the entire field. Such a view may help toward a better understanding of the mutual obligations involved and toward a fuller coordination of effort.

FOREST RESEARCH BY FEDERAL AGENCIES

Federal responsibility for conducting forest research arises from (1) the obligation to meet national or regional problems of forest-land management and forest-products utilization, and (2) the obligation to administer productively and wisely the immense areas of Federal forest lands. Federal forest research subjects are divided among a number of bureaus, mostly of the Department of Agriculture, as follows: Timber production and utilization, forest-fire protection, forest-range management and utilization, forest economics, forest influences, and related matters, the Forest Service; forest diseases and decays of forest products, Bureau of Plant Industry; forest insect infestations, Bureau of Entomology; preparation and use of naval stores, Bureau of Chemistry and Soil; forest wild life, Bureau of Biological Survey; game and food fish in forest waters, Bureau of Fisheries in the Department of Commerce; and weather relationships to forest fires as a basis for forecasting, Weather Bureau. Almost all the forest research of the Forest Service, and much of that of other Department of Agriculture bureaus, is concentrated at 11 regional forest experiment stations and the Forest Products Laboratory. Although great progress has been made, the areas and values involved are so large and the problems arising in connection with them so complex and difficult that this progress constitutes no more than a good beginning. Facts and figures cited in many sections of the present report reveal the enormous size of the forest-research task that lies before the Nation. The same national responsibilities that gave rise to the present research activities now require even more urgently the development of these activities to keep pace with growing needs.

FOREST SERVICE RESEARCH

The progress so far made in research by the Forest Service is discussed in the section "Research in the United States Forest Service: A Study in Objectives." The present forest research program of the service, as of other bureaus of the Department of Agriculture, is embodied in the McSweeney-McNary Forest Research Act of May 22, 1928. This act specifies what work may be undertaken in the entire field of forest research, sets up a field organization for systematic coordinated research, and outlines a 10-year financial program with restrictions as to appropriations.

Five years' systematic advance on the McSweeney-McNary forest-research program has made it clear that even if appropriations during the next 5 years reach the full amounts authorized by the act, at the end of that time only a good start will have been made toward covering a research field proportionate with national needs and responsibilities. After the expiration of the 10-year period provided for in the act, i.e., in 1938, funds for further research may be provided either under the clause in the present act which authorizes "such annual appropriations as may thereafter be necessary" or under legislation setting up an entirely new financial plan. The section previously referred to discusses some modifications needed in the McSweeney-McNary Act even before that time and outlines a financial plan for the decade beginning with 1935, which is about as far in the future as financial planning for research can be carried with much certainty.

The major objectives of the program proposed for the decade 1935–44 are (1) to round out the plan and development of the regional forest experiment stations, this to include establishing one or two new regional stations in the United States proper and one station each in Alaska, Hawaii, and the West Indies and developing a central laboratory as a part of the Forest Products Laboratory at Madison, Wis., for intensive research in fundamental silvicultural problems that require laboratory facilities; and (2) to round out the development of the Forest Products Laboratory.

Attainment of these major objectives involves development of the classes of research listed in the following table. This table shows the expenditures authorized by the McSweeney-McNary Act, and the average annual increases necessary during the four years 1935–38 and the six years following in order to attain the objectives set up for that decade.

Financial plan for Forest Service research for the decade 1935–44 [1]

Appropriation item	Annual expenditures authorized by the McSweeney-McNary Act for the decade ending with 1938	Average annual appropriation increases needed for the decade 1935–44—	
		To meet McSweeney-McNary Act authorizations or supplementary needs during the 4 years ending with 1938	To meet further needs through 1944
Forest management	$1,000,000	$115,000	$100,000
Range investigations	275,000	40,000	50,000
Forest products	1,050,000	110,000	100,000
Forest economics	250,000	45,000	25,000
Forest survey	250,000	[2] 80,000	----------
Erosion-streamflow	----------	[3] 100,000	40,000
Forest land classification	----------	[3] 50,000 to 75,000	----------

[1] All dates refer to fiscal years ending June 30.

[2] The efficiency of the survey will be greatly increased if maximum annual expenditures authorized by the McSweeney-McNary Act ($250,000) are reached by the fiscal year 1935 and are increased by new legislation to $500,000 for 1937 and thereafter until survey expenditures total $3,000,000. The three annual increases suggested to reach the maximum of $500,000 are $80,000 in 1935, $125,000 in 1936, and $125,000 in 1937.

[3] New legislation will be needed.

For the last three subjects listed in the table, financial authorizations beyond those provided by the present McSweeney-McNary Act are recommended. Appropriations for erosion-streamflow investigations were not specifically authorized in the McSweeney-McNary Act. A bill to authorize such appropriations that is now before Congress will be discussed later in this section. Secondly, the efficiency of the forest survey depends largely upon speed of execution. Within the limit of $3,000,000 set up for the survey by the McSweeney-McNary Act, a doubling of the present authorized annual expenditures would greatly increase its effectiveness. A third subject is forest land classification. Forest lands are an important factor in the national land-use problem which has risen to serious proportions within recent years, and forest land classification is correspondingly important as an aid in its solution. Participation of the Forest Service in forest-land aspects of classification can be provided by amendment of the McSweeney-McNary Act or as a part of a general authorization for all classes of lands.

These three subjects are discussed at greater length under their respective titles in the review of Forest Service investigative activities which follows.

FOREST MANAGEMENT

The central objective of forest-management research is to determine the conditions and efficient technical methods for raising timber as a crop. Its field includes methods of cutting timber or utilizing it for such products as naval stores in such a way as to perpetuate and improve the stand, growing and planting forest trees, protecting forests from fire and evaluating fire damage, increasing the value of stands by cultural methods, determining and forecasting timber growth rates, compiling tables to show the volumes of trees and the yields of timber stands of different sizes and ages, and other subjects, research on which is of fundamental value to forestry. The results so far obtained have added greatly to the assurance of results from efforts to grow and manage timber.

Although a substantial fund of knowledge on various forest-management subjects has accumulated for different regions and different forest types, an extremely large field of work remains to be covered. In many important forest types, work along some of these lines has made only slight progress, if any. In the subject of natural reforestation much fundamental work remains to be done, and the problem of carrying established stands through to maturity is, in general, still in a preliminary, empirical stage.

Research in artificial reforestation has made good progress, but the gaps in our information on this subject are still large. The work thus far has been almost entirely on conifers; how to establish plantations successfully has yet to be determined for most hardwood species and types. In the field of forest mensuration, volume tables and yield tables for even-aged stands have been made for many species and types, and these have proved very useful; but only a little has yet been done on the fundamental laws governing the form of trees, or their growth, or the yield of uneven-aged stands. Quality of product, as contrasted with quantity, has received practically no consideration in either volume or yield research.

The urgent need for better and more extensive protection of forests from fire has directed research effort into this field, but so much remains ahead that what has been done is only a beginning. Marked progress has been made in developing a technique for determining the efficiency of protective organizations through statistical studies of their fire records. Some studies have been made of the conditions that influence fire behavior. These subjects, however, require a great deal of further investigation, and others have scarcely been touched. For example, while studies of fire damage have yielded promising initial results, little progress has been made in any forest type or region in finding methods for determining with any certainty the damage caused by fire. Such information is extremely important in all forest types as a primary means of determining direct and indirect loss from fire, justifiable expenditures in forest fire protection, and the silvicultural measures made necessary as a result of damage. Research on the silvicultural use of fire lies almost entirely ahead, as well as research on the possibility of reducing the menace of fire through silvicultural management.

Numerous fields of forest-management research as yet have hardly been touched. Among these are forest regulation, or the systematic chronological adjustment of forest yields on the basis of growth rate, types of product, and other considerations affecting efficiency in timber production and supplying data for financial planning; engineering problems concerned with permanent road or other transportation systems and road and trail systems for fire protection; problems connected with park forestry, or with the growth and health of shade and ornamental trees; and the improvement of trees by selection and crossbreeding.

Progress of research in all these lines—and this applies generally to most of the Forest Service research subjects discussed later—has shown the need for more and more intensification of effort. In fact, the chief present requirement of most forest research is the breaking down of broad subjects into smaller component problems susceptible of solution under more intensive methods than have been possible with the funds so far provided.

A large part of this forest-management research is of value to the States, from the point of view of State, county, municipal, and private forestry. The concentration of Federal forest-management research at regional stations gives to groups of States effective local sources of information on a large variety of subjects.

RANGE INVESTIGATIONS

Forage for livestock is an important product of large areas of land on or adjacent to the national forests in the West. Overgrazing, where it has been permitted, has reduced forage production far below capacity. Unrestricted grazing has had a detrimental effect on forests and remains a threat to their existence. It is causing injury to soil and to watershed values through erosion following depletion of the protective plant cover. How depleted range areas may be restored to a fully productive condition can be determined definitely and completely only by research. Successful management of the range requires a knowledge of the degree to which grazing can be practiced without materially interfering with timber production or reducing the quality of the forage below specified standards.

To supply such knowledge, the Forest Service range investigations have been centered upon the relation of range use to timber growing and watershed protection, and upon the management of the range resource. They have dealt with the problem of handling livestock on the range only as it affects sustained forage production. Some important principles of grazing use have been developed, including the necessity of (1) a very conservative stocking of the range, on account of the striking decrease in growth of range plants during dry years or dry cycles; (2) allowing palatable vegetation to make vigorous growth before it is grazed; (3) giving bunchgrasses periodic opportunities to re-seed; (4) grazing sheep and goats openly and quietly and bedding them down in new places every night; and (5) obtaining better distribution of cattle on the range by means of well-placed watering places and better salting methods. This research includes 25 years' study of the value, distribution, and natural habits of many species of forage plants present on the western range. Progress has been made in determining the character and quantity and also the cause of damage by livestock to forest reproduction and in working out forms of regulation to minimize or prevent damage.

Range research is now under way in only four forest regions in the West. The need for it is by no means confined to the regions and types where it has been concentrated. Investigations should be extended as soon as possible not only to other western forest types and regions but also to eastern regions where range use now accompanies or could accompany timber growing.

The same need exists as in the case of forest-management investigations of breaking broad problems down into smaller component parts that can be attacked more intensively and successfully.

Forest Service range research has much value for States and also for private owners of range lands as a means of developing their grazing resources. While the Forest Service research is regional in scope except where national-forest problems are concerned, it has direct importance to the States as a means of improving and perpetuating both the livestock industry and timber production.

The need for expanding and intensifying range research that has been pointed out justifies the full volume of appropriations authorized by the McSweeney-McNary Act and the continued increases here recommended after the close of the period covered by that act.

FOREST PRODUCTS

The principal objective of forest-products research is to aid in making timber growing more profitable through more efficient utilization, and to aid in providing the public most economically with needed forest products in the form that will render the most satisfactory and efficient service.

Wood meets keen industrial competition in many fields. The competition offered to wood by other materials—for example, steel, concrete, and brick for structural purposes, and different vegetable fibers for fiber-board manufacture—is due largely to research, which has worked out adaptations, found new uses, improved qualities, and lowered production costs. Wood can fully meet this competition only if it is given the same advantage.

Forest-products research is one of the most effective means of enabling wood to meet the competition of other materials, of keeping up or increasing the consumption of wood, and thus of helping to insure productive and profitable use of forest land.

The major subjects now being studied at the Forest Products Laboratory are discussed in the section "Research in the United States Forest Service: A Study in Objectives." They cover the whole field of wood utilization, from the cutting of the tree to the grading, selection, and conditioning of forest products; the fundamental study of wood properties; the modification of these properties to resist decay, fire, or shrinkage; methods of pulp and paper manufacture, and the use of new species of trees for paper; the design and adaptation of forest products with reference to strength and other properties; and manufacturing processes such as gluing and painting. The laboratory tests are supplemented by the work of the forest experiment stations in various ways, notably through studies of the relation between growth conditions and wood quality.

In general, these investigations are directed toward increasing the yields of merchantable timber from forest land, utilizing waste material and tree species now considered inferior or worthless, and developing new uses and improved practices. As a source of aid to the States and to private timberland owners, many of the laboratory's researches are of great importance.

To reach the maximum authorization of $1,050,000 for forest-products investigations under the McSweeney-McNary Act by 1938 will require annual increases of $110,000 for the four years 1935–38, and the future development of this research on an adequate scale will probably require similar annual increases for a number of years thereafter.

THE FOREST SURVEY

The objective of the forest survey is to make an inventory of our forest resources, determining the exact extent of our forest-land area, what the land is now producing and can produce, how fast the forests are being depleted and the offsetting rates of growth, and the actual or potential wood requirements of the Nation. The survey proposes to analyze the many physical and economic factors that must be taken into account in working toward an optimum balance between our timber supplies and requirements. Its findings will bear directly upon the possibilities for forest use of millions of acres of reverting submarginal farm land.

The urgent present need in relation to the survey is for an increase in annual appropriations sufficient to complete the survey within the shortest possible time. This need arises because of the changes that are constantly taking place in the factors concerned and that will adversely affect the usefulness of the results in proportion to the time required to finish the work. Speed is important from a national standpoint but even more so for individual regions. It is estimated, for example, that the work now under way in the South, which contains 40 percent of our forest land, can be completed in 5 years if funds of $200,000 a year are applied to it. Obviously, the completion of the survey in this region within 5 years is greatly preferable to its protraction over a period 2 or 3 times as long, which would be necessary under present annual allotments. The survey has already built up an organization that can be quickly and easily expanded, under increased appropriations, to carry on a much larger volume of work, and to carry on the work to better advantage.

The seriousness of the economic problems to which the results of the survey will apply, and the comprehensive usefulness of the results to all agencies engaged in land-use planning, either nationally or from a State or local standpoint, and to timberland-owning and wood-using agencies, justifies as an emergency measure an immediate increase in the annual appropriation to the full amount of $250,000 authorized by the McSweeney-McNary Act and a still further increase, by special legislative action, to $500,000. The latter increase could be fully and effectively utilized by the survey by the fiscal year 1937, or even sooner.

It would be hard to conceive of a project that would contribute more to the development of forest-land use or to forest industry in the United States. The need to analyze and adjust our forest and land-use situation, which has long been in a highly confused state, has been brought into sharp focus by the present depression. In normal times our forest industries support approximately 9 million persons—wage earners and their dependents. They involve about 495 million acres of commercial forest land alone, which is more than the aggregate area in farm crops.

The survey is now approaching completion in western Oregon and Washington, is under way in the South, and is in progress on a small scale in the Inland Empire, California, and the Lake States. In the other forest regions it has not yet been started.

As the survey is completed in each region provision should be made for keeping the results current. The results can be made permanently useful only by constant adjustment in accordance with current forest growth and depletion, with changes in requirements, in utilization trends, and in the quantities and kinds of products made available by progress in forest management and with other factors. A service of this kind will require practically continuous but relatively small-scale work indefinitely for all forest regions of the United States. It will require annual appropriations possibly in the neighborhood of $200,000.

FOREST ECONOMICS

The controlling influence of economic factors upon forest-land use and upon tinber production and utilization gives the utmost importance to forest-economics research. Economic research as a basis for profitable timber growing, for the formulation of policies governing the use of land for forestry, and for solving many problems of the forest industries is being conducted by the Forest Service, but as yet on a scale far too small to meet the needs.

The McSweeney-McNary Act authorizes a maximum annual expenditure of $250,000 for these investigations. The first study under this provision was started in the southern pine region in 1930, and is now in progress. It is an investigation of timber-growing costs and returns or, more broadly, of the financial possibilities of timber growing by private owners. The southern-pine region was selected for the initiation of this study because of the extremely rapid forest growth made possible by soil and climatic conditions in the South, the accessibility of the region to large consuming centers, and a rapidly growing local interest in timber culture. The results of such investigations may be expected to stimulate private forestry initiative whereever they are carried on, and the time is ripe for extension of the work to all the important forest regions of the country.

Forest Service research in forest economics is designed primarily to supply a more thorough knowledge of the financial considerations and economic factors bearing on continuous forest production. When these investigations reach the full scale of the authorizations contained in the McSweeney-McNary Act, it is hoped that they can be made to cover all the following subjects:

(1) The conditions under which forestry is now profitable.

(2) The economic relations of forestry to other industries including agriculture, transportation, and mining.

(3) Economic and social gains from forest land use and from the availability of ample timber supplies, and the corresponding losses from forest land nonuse and timber shortages.

(4) Forest-land ownership, including the proper balance between public and private ownership.

(5) The possibilities of timber growing as a means of productively utilizing submarginal and eroding farm lands.

(6) Economic aspects of forest uses other than timber growing, such as recreation, hunting and fishing, and watershed protection, and of combinations of such uses.

(7) In what manner and to what extent the public should contribute to or regulate the handling of private forest lands.

(8) The basis of sound policies as to the administration of national forests and of lands in other kinds of ownership.

(9) Economic aspects of rotations, cutting cycles, and cutting budgets, and other subjects relating to forest regulation.

(10) The international situation as to timber supplies and markets, and other foreign relationships.

(11) The distribution of lumber and other forest products.

(12) The substitution of other materials for lumber, naval stores, etc.

(13) The trends of lumber and stumpage prices, and the principles that govern such trends.

(14) The place of productive forest-land use in the regional and national economic and social structure as a whole.

The need for information on these subjects justifies the recommended average annual increases of $45,000 to reach the McSweeney-McNary Act authorization of $250,000 a year by 1938, and of $25,000 for some years later. These increases would permit an expansion of the work proportional to that provided for in other fields of forest research. This need is sure to increase in urgency with the growing use of forest lands for timber production and other purposes. Naturally, the Federal results will be of great value to States and to private timberland owners, many of whose most difficult problems are of an economic nature.

EROSION—STREAM FLOW

The need for studies of the relation of forest and other vegetative cover of wild lands to the regularity of stream flow and to erosion is presented in the section "Research in the United States Forest Service: A Study in Objectives." This need is found in the growing importance of flood control in the United States; in the heavy erosion losses that have seriously reduced the productivity of enormous areas and threaten to reduce other once fertile areas to desert; in the critical need for water, which is growing with the increase of agricultural, municipal, power, and other demands; and in wide difference of opinion as to whether forest and other cover is a decisive factor in erosion and the regulation of stream flow. This difference of opinion is reflected in radical differences in policy or an entire lack of policy in the administration of public and private lands having watershed values, and in the disregard of forest influences that characterizes certain expenditures for flood control, improvement of navigation, and construction of costly dams and storage reservoirs. Flood losses in American river valleys are estimated to be at least $40,000,000 a year; river and harbor improvements by the Federal Government have cost approximately $1,800,000,000 to date; and a difficult and costly water-supply problem confronts many large cities. In the light of such costs, the condition of the vegetative cover of watersheds and the degree to which it can be modified to increase water storage, regulate the run-off, and decrease erosion assume nation-wide importance.

No specific financial authorization of erosion and stream-flow studies was included in the McSweeney-McNary Forest Research Act. A bill pending in the Seventy-second Congress would add to the act a new section authorizing annual appropriations for such studies not to exceed $500,000. It is extremely desirable that the full amount should become available by 1938, with annual increases for the four years 1935–38 averaging $100,000.

The values involved justify a further increase in the final 6 years of the 10-year program. An outline of the needs for investigation of stream flow and erosion problems in all the forest regions of the United States has been prepared by the Forest Service. The investigative program that would meet these needs would cost $750,000 a year. In summary, the full program is as follows:

1. Intensive erosion-stream flow studies which for specific sets of conditions will attack all phases of this problem, from intensive small-scale, closely controlled experiments measuring single factors to ultimate studies of larger duplicate or triplicate watersheds. Eighteen such intensive studies are proposed at an average annual cost of $25,000 each or a total annual cost of $450,000.
2. Supplemental and ordinarily less intensive studies dealing primarily with erosion but covering water relationships also. Twenty-six such studies are proposed, with an annual cost of from $5,000 to $20,000 each or $300,000 altogether.

The proposed amendment of the McSweeney-McNary Act to include specific authorization for forest-influence investigations would provide also for studies of the influence of forests upon climate and rainfall. Such investigations will probably be of greatest importance in the western treeless plains, although some incidental investigations may ultimately prove desirable elsewhere.

FOREST LAND CLASSIFICATION

The depression has brought to a head a land-use situation that is now one of the most critical of our internal problems. As shown in the section "Research in the United States Forest Service: A Study in Objectives", this situation is characterized by widespread abandonment of agricultural lands, particularly of the submarginal class; the breakdown of town and county government as a result of land abandonment and nonpayment of taxes; an unregulated back-to-the-land movement growing out of unemployment, with the prospect, in some instances, of further misuse of agricultural lands; and excessive erosion and floods following the cultivation of land that should have been kept in forest. Most of these features of the situation contain the seeds of even graver consequences. It seems vitally necessary that prompt and intelligent action be taken, upon the basis of a clear understanding of the uses for which the different classes of land are best fitted.

Classification of our existing and potential forest land according to the use to which it is best adapted is therefore made one of the objectives of the proposed 10-year research program. The classification would be based on information obtained through the Forest Survey and through investigations in forest economics and forest management and erosion-stream flow studies supplemented by information obtained through special studies of the character of the land, what it can be expected to produce, and related economic and social questions. Such studies should include the development of the principles for determining whether land should be used for agriculture, timber production, erosion control, recreation, or other uses or combination of uses.

Research by the Forest Service on the forest aspects of land classification must be conducted in close cooperation with agricultural experts working on the agricultural phases of the land-use problem.

Legislative provision for a study of the principles according to which land would be classified in terms of its best use might take the form of an additional section of the McSweeney-McNary Act, or of a general land-classification act. In the lack of detailed plans for such work the amount of money needed is uncertain, but as an approximation it would be well to provide for annually increasing appropriations averaging $50,000 or $75,000 for the period required, perhaps 5 years.

RESEARCH IN FOREST PATHOLOGY BY THE BUREAU OF PLANT INDUSTRY

Investigations in forest pathology by the Bureau of Plant Industry are discussed in the section "Protection Against Forest Diseases." They fall within the general subjects of (1) nursery and plantation diseases, including particularly the control of root diseases and the relation of susceptibility to source of seed, soil conditions, species mixture, and other factors; (2) disease resistance and its inheritance; (3) blister rust and mistletoe problems; (4) the rate of decay in trees, its outward evidence, relation to wounds, and control; (5) relation of decay to slash-disposal methods (to be studied in 10 forest regions in which slash disposal is a problem); (6) special methods of disease control for recreational forests, important because of the greatly increased use of forests for recreation and the marked difference in control measures applicable to recreational as contrasted with timber forests; (7) safeguards against the introduction of additional diseases; and (8) decay of forest products, including sap stain and "dry rot", and the relation of decay to methods of cutting, seasoning, and storing, to structural design, and to sanitation in lumber yards.

Continued active cooperation between Federal, State, and private agencies in these studies is contemplated. It is recommended that the pathological staff at the three regional forest experiment stations now served and at the Forest Products Laboratory be enlarged and that trained pathologists be placed at the remaining stations. There should be at least 2 pathologists, better 3 or 4, at each station, and 5 or 6 at the largest stations.

Progress in the development of Federal research in forest pathology should be insured by annual appropriation increases to reach the maximum of $250,000 in 1938, authorized by the McSweeney-McNary Act in addition to whatever sums may be required for emergency work relating to epidemic diseases.

RESEARCH IN FOREST ENTOMOLOGY BY THE BUREAU OF ENTOMOLOGY

While much has already been learned, through research, as to the life histories and habits of many destructive forest insects, leading to the formulation of methods for their control, there is need for a great deal more study into the fundamentals of insect ecology and physiology. For example, such studies may make it possible to predict insect outbreaks and consequently to prevent or better control them. Some of the directions which forest entomological research should take in the future, so far as can be foreseen, are indicated in the section entitled "Protection Against Forest Insects." Effort should be directed toward perfecting control methods and reducing their cost. Methods of control by distributing dust poisons from airplanes should be further investigated. A great deal of experimental work is needed to perfect methods of combating defoliating insects. Special study should be devoted to silvicultural methods of preventing insect attacks and to the use of parasitic insects as means of controlling insects injurious to forests. It has been demonstrated to be quite possible to import beneficial insects from one country or section of a country to another, establish them, and obtain effective control through their activities.

The maximum annual appropriation for Federal investigations in forest entomology authorized by the McSweeney-McNary Act is $350,000. The gradual annual increases authorized by this act should take care of the most imperatively needed studies for some 5 years to come.

RESEARCH IN NAVAL STORES BY THE BUREAU OF CHEMISTRY AND SOILS

Research in naval stores is being conducted by the Bureau of Chemistry and Soils. The work includes the development and demonstration of improved processes for preparing naval stores, including the weighing, handling, transportation, and uses of these products. A naval stores laboratory has been established on the Osceola National Forest, near Lake City, Fla., and approximately $31,000 has been made available for the investigations during the current fiscal year.

RESEARCH IN FOREST BIOLOGY BY THE BIOLOGICAL SURVEY

The important place of game and other wild life in forest management gives rise to the need of research in forest biology. The section "Wild Life a Forest Resource" indicates directions in which research is required. Research in this field is complicated by the great variations both in the composition of the forest and in the animal population. How much game of different kinds can be supported on given areas of forest land is a question that requires very much more definite and complete knowledge than now exists as to animal requirements, the availability of appropriate food and cover, and related subjects. The balance between different forms of wild life, as between game animals and animals that feed upon game, embraces another important class of problems. Game management research in forest biology has a much larger field ahead than that which it has been able to cover in the past. The increase of hunting, and particularly the growing recognition that under proper management game can be maintained perpetually as a resource on forest and wildland areas, have brought biological research to the fore.

Certain small animals apparently are beneficial silviculturally, because they feed on forest insects; on the other hand, rodents of various kinds frequently do much damage to the reproduction of forest trees. Both the beneficial and the destructive small animals are the prey of others, so that protection of the latter may in some cases benefit, in others injure, the forest.

Similar questions exist as to birds, some of which are valuable game, others predatory. Birds are known to affect forest conditions and values in innumerable ways. They destroy large quantities of harmful insects and perhaps beneficial ones as well. They distribute tree seed broadcast, and probably play a considerable part in the distribution of tree diseases. Predatory birds destroy rodents and other small mammals as well as other birds. Here again the biological balance is often critical. Research in both animal and bird life is constantly revealing new facts, the use of which is invaluable in formulating policies of forest and game management.

The program of biological research for the immediate future contemplates the carrying out of the provision covering this subject in the McSweeney-McNary Act, making available increasing annual appropriations which will reach the amount of $150,000 in the fiscal year 1938. The act provides that annual appropriations may be made thereafter of the size necessary to carry out the provisions of the act for biological investigations.

FISHERY RESEARCH IN FOREST WATERS BY THE BUREAU OF FISHERIES

The importance of fish as a forest resource, to be maintained and improved for public benefit, has been discussed at length in the subsection "Fishery Management in Forest Waters of the United States". So many technical problems are involved in establishing any comprehensive program of fishery management of forest areas that scientific research is essential. This research is conducted by the Bureau of Fisheries.

This research, outlined in more detail in the section above referred to, includes, first, a physical assessment of forest areas from the point of view of water resources, fish populations, and the demands made upon the natural supplies of fish by fishermen. Many factors enter into this physical assessment, such as the location and dimensions of streams and lakes, the flow of streams and their seasonal fluctuations, the character of stream beds, the extent of ripples and pools, the physiography of watersheds, and the chemical composition and thermal relations of water. Reasonably complete information is necessary also as to the kinds and quantities of organisms present in the water or on adjacent land that are available as food for fish. A further requirement is an inventory of existing fish populations, involving determination of the numerical relation between different kinds of fish, as a basis for determining the maximum number of food fishes of the most desirable or useful sizes that can be produced on a given area.

The existing or potential demands upon the supply of fish cannot now be determined satisfactorily because the facilities for doing this are very inadequate. A complete program of fisheries management should include the furnishing of such figures not only to determine the need for additional production but to provide a more accurate check upon the success of methods to increase the yields.

More extensive studies are needed of the ecological requirements of fish to be planted. These involve controlled experiments to determine means of augmenting the food supply, the value of various foods, the effect of competing species upon each other, proper levels of stocking intensity, the migratory and breeding habits of various species, and the general effects of individual systems of management.

Closely associated with the ecological investigations are laboratory studies for the purpose of improving hatchery technique. Notable progress has been made by the Bureau of Fisheries in certain directions through such studies during the past few years, but much remains to be done.

To carry out these research functions as a part of the proposed fishery survey in each of the six national-forest regions of the Western United States a resident biologist should be stationed in each region, together with sufficient technical personnel to assure acquisition of the most essential information at the earliest moment. The volume of work ahead is sufficient to cover a long period of years; but even the information obtained by a single season's operations will provide a far sounder basis for fish stocking in the area covered than exists at present, and within a few years' time a sufficient area could be brought under scientific control to augment vastly the supply of food and game fishes and to assure their perpetuation. The estimated cost of the needed fishery investigative work is $25,000 a year.

FOREST FIRE WEATHER RESEARCH BY THE WEATHER BUREAU

A weather-forecasting service to furnish warnings of approaching periods of dangerous fire weather is of material benefit to forest fire protective agencies, permitting increased flexibility of the protective forces, better control of forest fire situations, and generally much increased certainty and efficiency of operation. To provide for "such investigations at forest experiment stations, or elsewhere, of the relationship of weather conditions to forest fires as may be necessary to make weather forecasts," the McSweeney-McNary Act authorizes annual appropriations of not more than $50,000.

Since each forest region presents its own distinct problems, fire-weather research is being carried on to a greater or less degree at all the points at which the fire-weather forecasting system has been inaugurated: San Francisco, Seattle, Portland, Spokane, Chicago, Boston, and Asheville. Further extension is extremely desirable. The fire-weather research program for the future therefore merits the provision of the amounts authorized in the McSweeney-McNary Act, reaching an annual appropriation of $50,000 for the fiscal year 1938, with such appropriations thereafter as may be necessary to carry out the provisions of the act for this subject.

FOREST RESEARCH POSSIBILITIES OF THE NATIONAL ARBORETUM

Completion of purchase plans for the National Arboretum at Washington, D. C., and provision for its administration should be included in the forest-research program. The value of arboreta in forest research was discussed in the section "Privately Supported and Quasi-Public Forest Research". Arboreta afford opportunity for comparing characteristics, behavior, hardiness, and forest value of trees from all parts of the world, and for carrying on investigations in numerous special fields. Among these are the improvement of trees through cross-breeding and selection; physiological processes relating to growth, reproduction, water conduction, nutrition, and soil and other environmental influences; susceptibility to insect attacks and diseases; form and quality of timber; and other characteristics that bear upon the success of the species studied when introduced into the practice of forestry.

The presence at Washington of so many scientific bureaus engaged in different phases of forest research is a logical reason for the early completion of a national arboretum there and for its maintenance as a research center. Efforts to accomplish this have hitherto been only partially successful. By an act approved March 4, 1927 (44 Stat., 1422, U.S.C. Supp. VI, title 20, secs. 191–194), a sum not to exceed $300,000 was authorized to be expended under the direction of the Secretary of Agriculture for the acquisition of land within or adjacent to the District of Columbia "to establish and maintain a national arboretum for purposes of research and education concerning tree and plant life." The act specifies that the arboretum shall be administered by the Secretary of Agriculture "separately from the agricultural, horticultural, and forestry stations of the Department of Agriculture, but it shall be so correlated with them as to bring about the most effective utilization of its facilities and discoveries." A suitable tract of land was found but the initial appropriation was sufficient to purchase only a part of it, and further appropriations to round out the purchase have not yet been forthcoming. The next step is to complete the purchase program and provide such funds as may be needed for research.

FOREST RESEARCH BY THE STATES

The States have good reasons to contribute substantially to forest research. One reason is the responsibility for good administration of State-owned forest land, which has reached a total of 16 million acres and is increasing. An even more pressing reason is implied in the 444 million acres of privately owned forest and woodland, the good or bad management of which is in many ways a powerful determining influence upon State prosperity.

Nearly every State has local forest problems that it can not expect the Federal Government or any other agency to solve except in part. These problems are of great variety, from those connected with the planting, management, protection from fire, and utilization of the forest to forest entomology, pathology, economics, the protection and management of game and other wild life, and the use of the forest as an agent in retarding erosion and regulating streamflow. The importance of research to meet these problems and develop the many functions of the forest has been emphasized in this section and other sections of the present report. It justifies the belief that State contributions for research should be in a measure proportionate to Federal expenditures; that within about the next 10 years the States could well afford to undertake a share in the forest-research program amounting in the aggregate to $2,500,000 a year, which means an average expenditure of $52,000 by each State. Some States, of course, have much more at stake than others, so that the amounts needed for research are very unequal.

State agencies available for this research include the State forestry administrative organizations; specialists in entomology, pathology, wild life, or other subjects connected with other State departments; State forest schools or forestry and other departments of State universities and colleges; and State agricultural experiment stations. The part to be taken by each of these agencies in State plans for forest research is of course a matter for determination by individual States.

Expenditures of State forestry departments for forest research in 1932 were quoted in the section "State Accomplishments and Plans" as approximately $97,800, which is less than 2 percent of the total appropriations of the State forestry departments. This amount covers only the sums definitely allocated to research. Undoubtedly there were other State expenditures for research, but even if these amounted to $50,000, which is unlikely, the aggregate was only a little more than $3,000 for each State, an insignificant amount in view of the forest values involved.

Pennsylvania, spending about $21,000 annually on its Forest Research Institute, leads the States in amount spent for forest research by State forestry administrative organizations. This may be more than many of the States can undertake at present. With more than 16 million acres of forest land already in State ownership and 1,398,000 acres in the ownership of counties, and municipalities, and with further growth anticipated both in the area of land so owned and in the intensity of its use, a large increase in forest research by State forestry departments or other State agencies seems inevitable. The large area of timberland privately owned, amounting to 396 million acres in the class of commercial forest alone, calls for special activity in the classes of research involved in extending immediate aid to private timberland owners. The burden of this class of research may appropriately be distributed among the State administrative organizations, the forest schools and agricultural colleges, and the agricultural experiment stations, in whatever manner may best fit the organizations in individual States.

The State forest schools, of which there are 22 in 19 States, have not as yet developed their research activities to the point of full usefulness to the States. The estimate of aggregate research expenditures in 1932 by forestry and other departments of State universities and colleges, which is presented in the section "State Accomplishments and Plans," is $165,000.

The forest schools, together with State colleges and universities that do not provide forestry instruction might be made the agencies for a large extension of forest research. Without the heavy burden of administrative and advisory duties that rests on the State administrative departments, it would be possible for them to give the uninterrupted attention that is one of the prime essentials for research.

According to the estimates in the section "State Accomplishments and Plans," the State agricultural experiment stations are spending on forest research something like $55,000 a year, of which about $14,000 is Federal grant funds. In addition, those of certain Western States are spending about $75,000 for range research.

The agricultural experiment stations have some advantage in handling farm-forestry problems, because of the close association between farm woodlands and other parts of the farm. Farm woods make up about 25 percent of the entire forest area of the country (from 30 to 50 percent in the Southern, Middle Atlantic, and Central States). Because of the great aggregate extent of farm woodlands and the value of the materials cut and sold from them, farm-woodland products rank among the leading farm crops in a number of States. Under complete forest management farm woodlands can undoubtedly be made to produce much more than they now yield, with improvement in quality and value. Their problems differ in important respects from the management and utilization problems of extensive timber tracts.

FOREST RESEARCH BY QUASI-PUBLIC AND PRIVATE AGENCIES

The estimated annual expenditures for forest research by quasi-public and private agencies, discussed in the section "Privately Supported and Quasi-Public Forest Research," indicate that nearly 90 percent of all the forest research now conducted by such agencies is being done by the various wood-using industries. The estimates for the several groups are as follows:

Industries	$2, 500, 000
Scientific institutions and arboreta	230, 000
Privately supported forest schools and university departments	120, 000
Total	2, 850, 000

The largest share of the forest research being conducted by industries is carried by the pulp and paper industries, with estimated present expenditures of $2,000,000 a year. Other wood conditioning and manufacturing industries, including the lumber industry, are conducting forest research at an expense of perhaps $500,000 a year in the present period of depression. Much the larger part of this is for experiments in manufacturing and processing forest products rather than in growing them.

There is reason for a large expansion of industrial forest research in both the manufacturing and the productive field. Eighty per cent of all industrial forest research expenditures appear to be on pulp and paper, the form of product for which competition from materials other than wood is least serious. In the fields where competition is keen the research on wood seems to be very inadequately supported.

Research is one of the most effective weapons at the disposal of the lumber and other forest-dependent industries which are now fighting the competition of other materials. As was stated previously, by using research the competitors of wood force similar action upon the forest industries. Research is the means for showing in what respects and for what uses wood is the most satisfactory and cheapest material, and how it should be handled and used. Just as in all other forms of industry, research in the manufacture of forest products offers opportunity for cheaper and more effective methods and processes, reduction of waste, and hence a competitive advantage in price and quality. It offers the opportunity to exclusive rights through patents for improved processes and superior products. The individual manufacturer or timberland owner cannot depend upon Government, State, or university research organizations for all the forest research he will need. Such organizations cannot be created or developed rapidly enough.

If forest research is to be conducted by industries on a scale at all commensurate to the needs it would appear to require at least a 30 or 40 percent increase over the present expenditures, or the building up during a period of, say, 10 years of an annual expenditure amounting to $3,500,000. These expenditures would, of course, be made in different ways. Organization of special research staffs would be practicable in some instances; consulting experts can be called in periodically; contributions can be made as cooperative funds to research institutions at universities, to State organizations, or to the Federal Government; or research organizations may be supported in industrial associations from proportional contributions.

The agencies thus far discussed are conducting research as a part of other forestry activities. A different situation is presented by the endowed scientific institutions referred to in the section "Privately Supported and Quasi-Public Forest Research." These are engaged in research exclusively; but with one or two exceptions their research bears only incidentally upon forestry.

The institutions with organized botanical or economic departments could give greatly increased service to forestry within these fields. To furnish substantial aid to forestry, however, the research approach should be from the distinctive forestry point of view. Silviculture in America is seriously handicapped by the dearth of knowledge in the domain of tree physiology, genetics, and related sciences. In the field of physiology the functioning of trees, their reactions to environment, the characteristics that underlie susceptibility and resistance to climatic and other factors, are only a few of many subjects that have fundamental importance for silviculture and that as yet remain practically unexplored. Very little has yet been done to determine the possibilities of improving strains by cross-breeding and selection, and the same is true of many other lines of investigation that hold great promise for the future. The scientific institutions and arboreta are appropriate agencies for conducting fundamental research on these subjects.

Although more active participation on the part of existing scientific institutions is greatly to be desired, the breadth of their research fields prevents the necessary concentration of effort upon the specific field of forestry. Forest research has two features that probably distinguish it from any other field of scientific endeavor and that make necessary a special mode of attack: The complexity of the problems, and the long time required for results. Between different classes of factors highly important relationships exist which compel a systematic and organized group attack from many angles. Failure to coordinate research efforts results in confusion, duplication, and delay. European experience, cited in a report of the Society of American Foresters,[1] reveals the inadequacy of uncoordinated or desultory forest research:

> One of the serious handicaps of all except possibly the most recent fundamental forest research of Europe is its scattered and fragmentary character. One investigator examines a single narrow phase of tree growth or requirements. It may be the change in stored food substances in the tree upon the approach of winter for a single species, light intensity and photosynthesis in one or two species, the use by a single species in one locality of diffused light, nitrogen fixation by a very limited number of bacterial organisms, or some local phase of soil acidity. Each investigator works independently of all others. Exceedingly valuable information results, but fragmentary, full of gaps, and difficult or impossible of correlation. It furnishes, for example, in the aggregate, a part of the soil requirements of one species in one locality, a part of environmental light relationships of another species somewhere else, an isolated phase of the physiological activities of a third species.

Neither the scientific institutions with their broad research commitments, nor the forest schools with their educational obligations, nor public forestry agencies burdened not only with administrative responsibilities but also with the imperative demand for workable solutions of emergency problems, can fully supply the need for a systematic and sustained program of fundamental research.

---

[1] A National Program of Forest Research. Report of a special committee on forest research of the Washington Section, Society of American Foresters. Pp. 232. American Tree Association, Washington, D.C. 1926.

Two general suggestions have been made for meeting the situation. The Society of American Foresters report just cited recommends a national privately endowed institution of forest research with a governing board similar to that of one or another of the existing scientific research institutions, with adequate representation of public, scientific, and business interests. The single objective of this institution would be forest research as a fundamental aid to forestry. Since forest research requires, in general, an entirely different technique and background from that of other research, such an institution could undoubtedly be best developed as a distinct organization. Absorption into another institution with many lines of work under way might retard or prevent the fulfillment of its central objective.

The institution should, however, be prepared to subsidize carefully selected projects at other institutions, and to furnish facilities for special work to representatives of such institutions.

Field stations, experimental forests, and laboratories would be required. In locating these the highest feasible concentration among the different lines of forest research should be observed. This alone will insure the desired contact between scientists investigating related problems, and make possible a thoroughly coordinated and effective attack upon all the fundamental phases of forest life and environment. This maximum concentration might involve maintaining two or three main field laboratories in the United States and others in Canada and the Tropics. Arrangements should be highly flexible, permitting the investigators to work temporarily at any advantageous point, either independently or in cooperation with other research institutions.

The second suggestion was made in a recent report [2] to the Committee on Forestry Research, National Academy of Sciences. This report points to the fact that the basic experimental aspects of plant science have not yet been brought to the point at which they can be applied in silviculture, and that "A new science of forest physiology, involving both physiology of the tree and of the forest, must be developed. * * * The physiological approach * * * offers a rational means of advance to other basic aspects of silvicultural problems" extending over an extremely wide field and contributing materially "to the solution of the more complex problems of forest production."

As possible agencies for this work the report discusses all organizations now engaged in forest research. It gives paramount importance to a clearly visualized and assured long-term forest-research policy, which it is difficult to safeguard in universities. No single university, according to this proposal, should have to assume entire responsibility, nor should an undertaking like this be farmed out in disjointed fragments to existing university departments.

The report to the National Academy of Science contends that in the long run—

> the interests both of forestry and of educational institutions can be served best if the task of initiating, developing, and guiding researches in the more basic experimental aspects of forest production is assumed by some special administrative agency

which should be "free to accept funds from various sources for consistent and carefully planned projects". The institution thus envisaged would administer the contributed funds in such a way as to correlate and coordinate disbursements, according to the gradual elaboration of plans based upon intensive cooperative researches.

---

[2] Bailey, I. W., and Spoehr, H. A. The Role of Research in the Development of Forestry in North America. P. 118. The MacMillan Co., New York. 1929.

The National Academy report recommends not—

> the creation of a single, large, isolated research institute, but rather the development ultimately of several smaller research units which should be located in university centers and affiliated more or less informally with existing scientific departments.

Either one of these two plans, or any combination or alternative offering corresponding advantages, would constitute a tremendous advance in furnishing the information so badly needed in the management of our forests. In one form or another such a concentrated attack on the fundamental problems of forestry should go forward. It would afford the means for rounding out and stimulating the forest-research effort of all agencies. With the highly competent personnel, the field stations, experimental forests, and laboratories that would be required, a program of this nature could hardly be adequately financed without an annual income of at least $1,000,000.

With a reasonable increase in the forest-research activities of the various existing scientific institutions, arboreta, and botanical gardens, it is estimated that an adequate total annual expenditure by all institutions would be in the neighborhood of $1,500,000.

The funds at present spent on forest research at endowed educational institutions are estimated to total $120,000 a year, divided equally between organized forest schools and other university departments.

Like the State forest schools and agricultural colleges, these institutions are highly appropriate centers for forest research covering a wide field of subjects. Present expenditures for forest research are far below what appears to be their full opportunity for service. It is reasonable to set up, as an estimate for future expansion, a figure 3 or 4 times as large. An annual expenditure amounting to $500,000 would represent more completely the research potentialities of these schools.

For all the private or quasi-public agencies considered in the previous discussion the suggested future forest-research program would involve the following expenditures:

Industries	$3, 500, 000
Scientific institutions and arboreta	1, 500, 000
Forest schools and other departments of endowed universities	500, 000
Total	5, 500, 000

FOREST EXTENSION—AN APPRAISAL AND A PROGRAM

By I. F. Eldredge, Principal Economist

CONTENTS

Page
Federal cooperation with agricultural colleges ... 1575
Forestry extension by Federal and State forest services ... 1576
Other forestry extension agencies ... 1577
An appraisal of the forestry-extension program of today ... 1578
A 10-year program ... 1581
The field of effort ... 1581

The mission of forestry extension is to spread a working knowledge of forestry. Like all other kinds of extension work, it is primarily educational and demonstrational in character. Its purpose is to bring about a widespread appreciation of the place of forestry in our national economic and social structure, to pass on to forest landowners, users, and managers all applicable knowledge of forestry and forest practice, and to demonstrate and interpret in the light of local requirements desirable practices in forestry—all to the end that the forest lands of the country may produce larger returns expressed in terms of both profit and human welfare.

That forestry extension is an essential step to better forest practice has of course been obvious to those interested in the forestry movement, and considerable extension effort, both organized and incidental has been carried on. But, as measured by the financial investment in it, it is doubtful whether foresters or their backers have realized one tenth of the results that might be attained through a serious and thoroughgoing program along extension lines. The main work in forestry extension at present is that being conducted by the States in cooperation with the Federal Government, but other agencies should not be overlooked. The following is a brief account of the various activities. More detailed discussions of the work appear in the preceding sections of this report.

FEDERAL COOPERATION WITH AGRICULTURAL COLLEGES

The cooperation of the United States Department of Agriculture with State colleges of agriculture is a Nation-wide forestry extension activity resulting from the operation of the Clarke-McNary law of 1924, its purpose being—

> to assist the owners of farms in establishing, improving, and renewing woodlots, shelter belts, windbreaks, and other valuable forest growth, and in growing and renewing useful timber crops.

Federal cooperation is administered by the Extension Service of the Department with the technical advice and assistance of the Forest Service. The extension is conducted as a part of the program of the 33 State agricultural colleges that cooperate, and is handled usually through State extension services as a part of the agricultural extension work. Federal funds appropriated annually, mainly under the authorization of the Clarke-McNary law, are used in the employment of State extension foresters who are the specialists and leaders in the forest-extension activity in each of the States. There is usually only one extension forester to each State.

The forestry-extension activity of the Federal and State governments in partnership costs annually a total of approximately $160,000, the Federal Government bearing about $70,000 of the total and the States furnishing $90,000.

While there is some direct contact with farmers in meetings and to a lesser extent by individual assistance, the extension foresters of the various States reach the farm owner mainly through the county agricultural agents, of whom about 1,000 in 46 States participated in 1931. The field of activity of the county agents is limited to farmers and farm owners, and the usual methods of agricultural extension work are employed in forestry extension. The results obtained more than justify the amount of money expended, but the field as a whole is only partly exploited, and there remain great possibilities in public good to be achieved from an expansion and development of the work.

FORESTRY EXTENSION BY FEDERAL AND STATE FOREST SERVICES

The private owner of timberland who is not also a farmer receives few, if any, of the benefits of the organized forestry extension effort; in fact, in many large and important regions, he gets very little direct attention from any source. Bulletins, both State and Federal, and occasional but rare opportunities for personal contact with some Federal or State forester are, as a general rule, as much as he can expect to get in aid or advice from public agencies.

The Forest Service publishes bulletins, circulars, and newspaper and magazine articles on forestry, and most of the State forest services have similar facilities; but neither in the Forest Service nor in the State services is there any adequate effort to give to the nonfarmer timberland owner service or assistance comparable to that made available to farm woodland owners. While many of the States manage to maintain some form of forest extension and charge considerable sums of their available appropriations to extension activities, the exigencies of fire protection, the first step in forestry, demand the larger part of their efforts and expenditures. As a consequence, only a few State forest services can truly be said to be meeting their responsibilities in reaching the private owner of the nonfarmer class with aid and advice as to handling his holdings along the constructive lines of forest management, utilization, planting and marketing.

The user of forest products receives more attention from the Federal Forest Service than does the timber owner. At the Forest Products Laboratory at Madison, Wis., the Forest Service maintains a small extension organization designed to carry into practice the knowledge and processes discovered through the research activities of the institution. Courses of training and instruction in lumber-kiln practice, boxing and crating, gluing of wood, and wood properties and uses are conducted on a cost basis for manufacturers, trade specialists, and salesmen. In addition, information is made available to the public through bulletins, periodical notes, and trade journals, as well as by correspondence and contact with associations.

The several forest experiment stations under the Federal Forest Service maintain considerable direct touch with the timber-owning public by group meetings and some individual contact, but the main effort is through correspondence and publications of various kinds, including the use of trade journal articles. They also reach the owner indirectly through the extension services of the Department of Agriculture and the several States.

The present annual expenditure for all State forestry extension service to forest owners in the entire United States is estimated at approximately $100,000. This sum covers the net State, county, and town expenditures for forestry extension in behalf of all private owners, including farm owners, and takes account of moneys spent by all State extension services, forest services, and other State and county bodies. It does not include contributions of private owners themselves or cooperative Federal allotments.

It is evident from the above that only a very small share of State and county activity is directed toward forestry extension, even though some incidental part-time services may not be included in the above statement. When it is explained that of the money set out for forestry extension, approximately nine tenths is spent, under the cooperative provisions of section 5 of the Clarke-McNary law, entirely upon one class of forest owner, namely, the farmer, it may be appreciated how neglected is the field of extension work among that large class of private forest owners who, while they do not happen to be farmers, actually own and operate about 270 million acres, which is more than half of all the commercial forest land in the United States and and about 70 percent of all the privately owned forest land.

OTHER FORESTRY EXTENSION AGENCIES

In addition to the work of the Federal and State agencies, a number of institutions and organizations are active in forestry extension. Several of the colleges and universities in which forestry schools are incorporated publish the results of their research. Some of them go farther and, to a limited extent, give advice in the handling of timber land in the nearby regions. National forestry associations such as the American Forestry Association and the American Nature Association, and several of the State or regional forestry associations publish and distribute printed matter covering the field of forestry and do much besides to encourage a better and more widely held conception of forestry. A small group of consulting foresters have been very active and have reached a rather limited number of private owners very effectively. A few of the large railroad systems, especially those whose lines traverse forest areas containing much cutover land, have interested themselves in encouraging better forest practices in their territories. Lumber and naval stores trade associations have in some cases also expended considerable effort in work along this line, as have some chambers of commerce, farmers' organizations, conservation and wild life associations, and women's clubs. The press, in general, has shown an enlightened interest, and has accorded generous publicity to efforts toward improving the forestry situation throughout the country. There is no question that its influence in spreading information and in educating public opinion in this respect has been a public service.

AN APPRAISAL OF THE FORESTRY EXTENSION PROGRAM OF TODAY

The organized effort that is being put into forestry extension, when the various agencies are enumerated and their fields of endeavor are surveyed, appears on analysis to be pitifully inadequate to the job at hand. When the wide-spread need in the field is compared with the part of it that has been met or even partly met, when the accomplishments to date are checked against what must be done, and when it is realized that only an organized, synchronized, well-directed attack can meet with success within a reasonable time and at a reasonable cost—then the inadequacy of the present program is felt in its full force.

The strongest, best financed, and most effective of the several forestry extension efforts is that being carried on as a part of the agricultural extension work of the State colleges with the Department of Agriculture cooperating. It is, as stated before, confined almost entirely to farmers and is therefore concentrated upon not more than 25 percent of the forest lands of the Nation. Yet even in this field, notwithstanding the earnestness of the agencies at work, it cannot be said that the ground is being covered. Farmers own and manage in conjunction with their fields and pastures nearly 127 million acres of commercial forest land. There are over 4 million farms with woodlands. The number of farms reported to have been directly reached by the extension effort in 1931 to the extent of actually effecting some improvement in forestry practice is 32,000, or less than one farm out of a hundred.

While there is no doubt considerable spread of good practice from farm to farm, the average farmer with woodlands today is not getting anything like the returns his little forest is capable of producing—not because of a lack of energy or even of capital, but simply because he does not realize the possibilities nor know the measures that are necessary to bring them about. Our program to reach the farmer with the information and advice needed to get the full returns from his forest is good as far as it goes, but it is far too lightly manned to cover the field.

If the farm woodland owner, served by the best organized and financed activity, is getting insufficient attention, what of the industrial timber owner who has no farm? In so far as public agencies are concerned this class of ownership is almost entirely neglected. The finest timber stands and the most productive and most favorably located forest lands of the country have been and are still held by this class of owner, and 80 percent of the lumber produced comes from their forests. If any forest resources have truly national significance, these forests and forest lands have. They have suffered most from devastation and deterioration, and the final results of their long-continued exploitation for immediate returns without heed of the future are to be found on a large scale in every section of the country. The progress of deterioration of forest stands and forest lands is still going on, not because it is impossible to handle them properly, but because the owners and the public generally are not yet alive to the means and methods of managing forests more profitably.

The East generally, and the Lake States and the Gulf States especially, have millions of acres of profitless, useless, tax-delinquent land that only recently supported splendid forests and were, and still are, capable of yielding a continuous flow of even finer products at low cost at the very doors of the consuming markets.

Despite uncontrolled fire and a disregard of the primary principles of forest culture, much of this potent forest land has restocked and is producing a second crop, but a crop poor in quality, small in quantity and long delayed in reaching maturity. The cost of producing such timber, because of these facts, is greater than would be the case under adequate forestry practice. Land and climate capable of producing each year 500 feet of good-quality lumber per acre, as they are in the shortleaf region of Arkansas, for instance, at a cost of 60 cents per thousand feet under adequate forest management is, as a result of common practice, producing less than a half of this amount of lumber at three times the cost and of poor quality in the main. The extensive forest lands of the Appalachian States that produced the finest stands of hardwoods in the world are still as potent as they ever were, but because of the disregard of simple requirements of forestry in the original logging and subsequent treatment they are coming back now to a scrubby, inferior forest that can not return to the owners, to the community or to the Nation more than one third of the potentiality of the soil.

In all of the forest regions of the United States, from coast to coast, privately owned forests and forest lands have been and are being subjected to a continuous process of deterioration in greater or lesser degree. This state of affairs is neither necessary nor unpreventable, and it is certainly not inevitable. On the contrary, in many cases it has cost as much in effort and money to defeat the fecundity of soil and climate as it would have cost to have taken full advantage of the favorable natural factors to grow more and finer forest crops.

At the bottom of the trouble is, first of all, a state of mind that does not understand and therefore fails to accept the principle of growing and harvesting successive or continuous crops of timber on the same soil, just as corn or cotton is grown and gathered. As a people, our experience in harvesting a bountiful virgin forest, the accumulated heritage of ages before the advent of the white man, is still too recent. Our anticipation of the immediate future is too eager. We are not yet patient enough to believe that what we will get even in one lifetime henceforth will depend upon our growing another crop on the lands we have cut over, rather than upon the possible opening up of some new territory rich in virgin timber. Because of this prevalent failure to sense the change that 200 years of settlement has wrought, there is an equally widespread inappreciation of the possibilities that lie in the business of using forest land for the growing of continuous supplies of timber.

It is true that owners of forest lands in this country are at present beset with many and serious difficulties in making their investments pay. In periods of low prices for wood products the owning of understocked forest lands by individuals and corporations always becomes precarious, and ownership shifts rapidly from hand to hand, eventually ending in abandonment to the State if no relief is found. But this is not inherent in the nature of forest ownership. It is no more necessary than it is desirable. Forest lands should be, and in the older countries are, the most stable of investments, passing for generation after generation from father to son, remaining always a firm base for family, community, and national wealth and welfare. This stability of ownership through the years is mainly due to care and skill expended upon the forests and their consequent high productive capacity.

No nation such as ours, in which so large a share of wealth is in the form of forests and forest land and tied up in the business of manufacturing, selling, and distributing forest products, can remain complacent in the face of conditions as they now exist in this country. In the section on the breakdown of private ownership in this report is treated in some detail the state of affairs that has developed as a result of mismanagement of our forest resources on the one hand and the inevitable working of economic laws on the other. The existing depression has only intensified a situation that has been building up for years. The farmer's woodland, where it is not reached by successful extension effort, is, by and large, becoming less and less a dependable, considerable source of cash revenue—and this in the face of greater need on the owner's part for an addition to the income obtained from his fields and pastures. The woodland is doing far less than it could to help stave off the foreclosure of the farm mortgage, to pay taxes, and to furnish seasonal employment for surplus labor. The farmer owns no inconsiderable part of our Nation's forest resources and furnishes a large portion of the country's wood material, and his distress is passed on to the rest of us in an inevitable economic cycle.

The effects of a short-sighted forest policy of land use and forest management are even more general and more serious in the case of industrial forests than in that of farmers' woodlands, and because the industrial forest investment must stand on its own merits and pay its way without aid from other income, the results may be all the more disastrous.

Any action that will ameliorate the conditions that prevail, and that have gradually been getting worse for years, will be felt with relief, not only by the owners of forest land, but by all classes of industry and by taxpayers everywhere.

Fortunately there is no reason whatsoever to believe that this situation will continue indefinitely. It has been brought about as a result of failure to appreciate the possibilities of intelligent forest management; it can be materially improved and eventually cured by the application of available knowledge, and that, too, by the average owner under average conditions. Within the last 30 years American foresters, engineers, and chemists have developed the technic of handling American forests and forest products to the point that there is actually available a fund of knowledge which, if applied generally, would reestablish and perpetuate our forests as a major source of national wealth, assuring the future welfare of our people as no other one natural resource could.

This fund of knowledge is not reaching the class who alone can put it to most telling use—the private timber owners. Federal and State Governments as owners are not the answer to our major forest problem. Our present forest extension efforts are insignificant either in comparison to what is needed or as measured against reasonable and justifiable objectives. We have the stimulus of urgent necessity for more income from our forests, we have the best forest lands in the world on which to work, and we already have an available fund of knowledge of how to make these lands yield greater returns. What remains is to get the knowledge into actual practice. That is the mission and the objective of forest extension.

A 10-YEAR PROGRAM

It is now proposed to indicate, in general, the program of forestry extension that may be expected within, say, 10 years to accomplish the maximum possible improvement of our deteriorated forest property and to put it well on the way toward the production of sustained and permanent values in our national economy. Such an undertaking is large because our country itself is large. The problem appears difficult because of the many and varied conditions interposed by regional, sectional, and local factors affecting forest growth, forest utilization, markets, and transportation, to say nothing of our highly decentralized political system and the marked differences in the customs and viewpoints of our people. But at that, this problem differs little, if any, from those faced in the usual course by all agencies, both governmental and industrial, that undertake country-wide campaigns of any kind.

On first approach the objectives would seem easiest and best reached through a single closely knit organization directed from Washington that would specialize in forestry extension and that would work through more or less decentralized but coordinated groups operating in the various forest regions of the country irrespective of State lines. If the United States were a small country like France or Italy, with comparatively homogeneous conditions, or had a highly centralized government or a dictatorship, such a plan would probably be most effective. But such is not the case, and any governmental plan or program to be successful must take into account the political and social structure of our country and the relationship of Federal, State, county, and community governments to each other, and adapt itself accordingly. Practical consideration dictates a line of action based upon and blended into the organizations that already exist, the facilities at hand and in sight, and methods of approach already developed.

THE FIELD OF EFFORT

In the first place, the extension effort must be directed toward three classes of people: (1) The owners of farm woodlands; (2) the owners, managers, and users of industrial forests; (3) the general public. The needs of each class with respect to forestry extension will be taken up in order.

OWNERS OF FARM WOODLANDS

The very considerable class of farm timber owners control about 25 percent of the forests of the United States. When farmers have learned what their woodland can do under care and are started in the right direction as managers, a great step will have been taken. A promising beginning toward this objective has been made, but the movement needs stimulus and expansion.

The farmer is to be taught, first, that his woodland is an important source of real and often of major cash income if handled skillfully; second, how to handle it skillfully and to produce the most material, of the best possible quality, at the least practicable cost; and third, how to harvest and market his output to the best advantage.

OWNERS AND MANAGERS OF INDUSTRIAL FORESTS AND USERS OF FORESTS PRODUCTS

The possibilities in improved forest management and practice in industrial forests are greater than in any other class of ownership, because almost universally they comprise the best sites and have been selected for advantageous harvesting and marketing of the products. The first task of forestry extension with respect to the industrial forest owner is to point out the increased financial returns that may be obtained from his investment through an application of better methods of timberland management and improved utilization of stumpage. In the great naval stores region of the South, for instance, the owner, through comparatively simple and inexpensive measures, including fire control, thinning crowded stands of saplings, and proper turpentining methods, may easily increase the net returns from his operations and supply himself at the same time with a sustained yield of timber, growing as fast as it is used. A few experienced extension men working in the naval stores belt could in a few years very materially increase the number of owners actively practicing forestry to their own advantage and to the advantage of the region, the State, and the Nation.

The second step of extension is to supply to owners whose active interest has been enlisted the available information that has been or is being established by research and by the practice of others bearing on problems at hand, and to interpret this information for direct application.

Users of forest products should be educated along lines of utilization of all parts of the tree to prevent waste, the merits of different wood products for different purposes, the use of wood in competition with substitutes, and the extension of wood products into new fields of use. These aspects of utilization are more fully treated in the section dealing with increased consumption of forest products.

THE GENERAL PUBLIC

To make substantial progress in extending better forestry practice there must be a much more general appreciation of what forestry is, what it can do and how it fits into the economic scheme of things. Until public leaders know more about it, there will always be difficulty in securing such legislation affecting protection, taxes, governmental aid, and other objects as may be essential to favorable development. Unless law-enforcement officers and State and county administrative officers are informed and appreciative, and unless the general public cooperates with them, forestry will not receive that degree of protection and fair treatment necessary for success. Bankers and others handling or controlling large quantities of capital, much of which must be used in growing timber, must have a knowledge of and confidence in the possibilities of forest culture—and so all along, to the man in the street and in the woods, whose carelessness with fire, largely due to a lack of understanding, is the cause of tremendous annual losses.

All classes of people must be reached and brought to understand first, that it is necessary for community and national welfare that there be forests ample in extent in each region to produce bountiful supplies of cheap wood products for building, for the railroads, for the factories, for fuel, for paper-making, and for national defense in times of emergency, and that forests are indispensable assets for stream control, for erosion prevention, and for those forms of recreation that contribute most to health and vigor. They must learn that our depleted or cut-over forest lands are capable of growing finer forests under reasonable care than the original virgin forests their forebears knew, and that with skill and knowledge these forests can be grown and harvested with greater profit to the grower and still offer forest products to the consumer at a price within his reach. They must be led to understand that the growing, culture, and harvesting of forest crops and the manufacturing of forest products presents a great opportunity to put men to work and to provide livelihood for millions that have been or may be crowded out of industry by the advance of mass production and labor-saving machinery. When the general public has been educated along these lines, then and only then will the business of growing successive crops of timber receive that support, material and moral, that is necessary to a reasonable degree of success.

One or more, and frequently all, of the three classes here referred to as subjects for forest extension are found in every section of the United States. It will hardly be possible, of course, to reach them all directly or to educate all who need educating. It is not necessary that each individual be reached. The knowledge of correct forest culture will gradually spread far beyond the direct influence of extension agents and eventually become a part of common knowledge, just as improved agricultural practices are adopted into common use among farmers. No great army of forest extension workers will be necessary to develop the project and carry out the extension mission, provided that a certain amount of organization and coordination is attained and careful plans are made and followed out with skill, determination, and enthusiasm.

The following is a conception of the organization needed to start the work; such an organization would possibly be sufficient for the next 10 years, after which time the situation should be reappraised and the work adjusted to the needs as found.

ORGANIZATION OF PROPOSED EXTENSION WORK

FARM FORESTRY EXTENSION

To expand the forestry extension work with farm woodland owners, the logical thing to do is to enlarge and strengthen the work now being done by the State agricultural colleges under the Clarke-McNary Act and the Agricultural Extension Service of the United States Department of Agriculture in cooperation with the Forest Service. The expansion of effort should not be uniform over the country but should be based upon the needs of the farmers in the various States for advice and technical information, upon the aid they are already receiving from other sources, and upon the relative importance of the woodland on the farms as a source of revenue—in other words, the States in the regions of most profitable forestry with the greatest number of farm woodlands would receive the most attention.

While some increase in overhead in Washington would be necessary, the greatest results will be obtained by expanding the field force. This might perhaps be best accomplished by increasing the number of extension foresters in a given State and allotting among them the different forest regions of the State so that each extension forester could be a specialist in the problems peculiar to a given forest belt. Their numbers should be sufficient to enable them to work directly with the farm owner as well as through the county extension agents. In extensively wooded or cut-over districts, such as are found in the upper Lake States and throughout the South, when the importance of the forest use of the soil heavily outweighs the strictly agricultural use, the county extension forester might even take the place of the county agricultural agent, or at least serve as his assistant. The following is the suggested field corps of extension foresters to be gradually built up during the next 10 years, shown in comparison with the force at present available for farm woodland work:

	Present number of extension foresters	Number needed by 1942
New England States	6	10
Middle Atlantic	7	10
Central	6	16
South	9	32
Lake	4	14
Rocky Mountain	4	7
Pacific Coast	1	5
Total	37	94

This increased force of farm forestry extension men should in itself bring about a marked showing in the more profitable handling of the farmers' woodlands and the improvement of his economic condition, but the movement would be given greater impetus if all county agricultureal agents in predominantly forest counties were required to take a basic college course in forestry or to undergo equivalent training. Other desirable changes from the present system would involve much closer cooperation with the United States Forest Service and its regional forest experiment stations and with the State forest services.

The cost of such an organization as suggested, including all necessary increases in overhead and increased participation of State forest services would be approximately $500,000 per annum. This cost should be shared equally by the Federal and the State Governments, in which event the necessary authorization for the Federal share should be $250,000 per annum to meet a like share to be contributed by the States on a basis of the expansion in field force indicated by the needs of each.

INDUSTRIAL FORESTRY EXTENSION

The present effort in the province of forestry extension to commercial owners in the country as a whole is weak, unorganized, and uncoordinated. The Federal Forest Service maintains only a small group for direct contact with private forest owners. Only 16 of the 48 States make any attempt to give advice and assistance to private forest owners, and in these States the work done is largely incidental and fragmentary. To accomplish what is needed, an effort as well organized and coordinated as that proposed for the farm woodland work will be necessary, and while the extension foresters in this work will have no county agricultural agents to help, the fact that the individual forest holdings are much larger and that the largest owners may employ foresters of their own or may consult private foresters suggests that a comparatively few men in each State, directed by the State forester and cooperating with the Federal service could start the movement satisfactorily and make real progress during the next 10 years. In any event, they should maintain effective contact and coordination with the farm forestry extension force.

If, say in 1942, it should appear that the acceptance of good forestry practice bids fair to become general, it is likely that forest owners will need less public assistance and will depend more upon their own resources. At present, however, the States and the Nation as a whole have so much to gain from a widespread improvement in industrial forestry that the public is justified in participating in the effort and in the cost of stimulating it. In providing for the organization of forestry extension work along these lines, the same principles should prevail that are proposed for setting up a revised farm forestry extension program. The effort should be most intensive where the opportunity is greatest for results of value to the Nation as a whole, that is, in the regions where, owing to favorable forest-growing and other conditions, the timber development offers the greatest advantage. The following is the suggested working force, by regions. The personnel shown are to be mainly foresters who will specialize in giving advice and assistance to private owners in the preparation of management plans, protection plans, silvicultural work, planting, and utilization, but the plan includes also a limited number of men for the more general forms of extension work.

	Staff needed
New England	6
Middle Atlantic	10
Central	10
South	40
Lake	12
Rocky Mountain	7
Pacific Coast	12
Total	97

It is estimated that this organization would cost $500,000 per annum. It might logically follow the half-Federal, half-State principle of sharing cost. A more flexible authorization, however, is needed in order to accomplish the extension that is justified, and indeed imperative, in this field.

ADDITIONAL FEDERAL ORGANIZATION

Necessary additional extension organization needed in United States Forest Service.—To play its part in the national program of forestry extension, the Federal Forest Service will have three distinct lines of responsibility: first, to cooperate with the farm forestry extension work of the Department of Agriculture; second, to cooperate technically and financially with and to coordinate the State forest services in their extension work with industrial forest owners; and third, to maintain a direct extension contact with certain classes of owners and industries, particularly in utilization matters. These responsibilities will require a force of 20 men or more, according to the extent to which the States meet their extension responsibilities, at an estimated cost of approximately $125,000 to $225,000 per annum, all at Federal expense.

A situation is likely to arise in which one or more States are unable to match Federal funds available for extension work among the owners of industrial forests. Nevertheless this virtually untouched field is of such importance nationally that it should be covered, even though the possibility of sharing the cost is nil. To meet such conditions it is recommended that an annual authorization of $375,000 be provided for a 10-year program under which there can be appropriated annually $225,000 for direct Federal extension in the fields described under this heading and the one next preceding, and as much more as may be matched on a share-alike basis by the States, up to the full amount of $375,000 per annum. Such flexibility in authorization will permit the Federal Forest Service to meet the needs for extension in the poorer States as well as the wealthy ones wherever national needs require.

The annual Federal authorizations required to carry out the 10-year program in all the phases proposed may be summarized as follows:

(1) For farm forestry extension, one half of cost	$250,000
(2) For industrial forestry extension, including $225,000 per annum for Forest Service and up to $150,000 per annum additional to meet State funds	375,000
Total	625,000

THE PROGRAMS SUMMARIZED AS TO RESPONSIBILITY: COSTS, FINANCING, AND NEEDED LEGISLATION

By Paul H. Roberts, Administrative Officer, Branch of Research; Willis M. Baker, Director, Central States Forest Experiment Station; S. B. Show, Regional Forester, California National Forest Region; E. L. Demmon, Director, Southern Forest Experiment Station; and I. F. Eldredge, Principal Forest Economist, Southern Forest Experiment Station

CONTENTS

Page

Introduction 1587

The responsibility for forestry 1589

The private owner's part 1594

    Responsibilities 1594

    Action required 1596

    Costs and returns 1597

    Financing the private owner 1597

The part of quasi-public institutions in forestry 1598

The part of the State and local governments 1599

    Responsibility of the State 1600

    The State forestry program 1600

The part of the Federal Government 1609

    The Federal Government's responsibility 1609

    Bureau of Fisheries (Department of Commerce) 1611

    National Park Service (Department of the Interior) 1611

    Indian Service (Department of the Interior) 1612

    Biological Survey (Department of Agriculture) 1612

    Bureau of Plant Industry (Department of Agriculture) 1613

    Bureau of Entomology (Department of Agriculture) 1614

    Bureau of Plant Quarantine (Department of Agriculture) 1614

    Weather Bureau (Department of Agriculture) 1614

    Forest Service (Department of Agriculture) 1615

    Summary of estimated Federal expenditures 1627

    Summary of legislation needed for the Federal program 1631

Financing the program 1632

    Financing of capital expenditures 1633

    Financing current expenditures 1635

    The offsets to Treasury drain 1635

    Other sources of Treasury income 1636

INTRODUCTION

During the last century, the forests of the United States have supported industries whose products were valued at close to $100,000,000,000. Forest products have been indispensable in the development of our mines and the construction and operation of our railroads and shipping. They have contributed many billions toward maintaining a favorable balance of international trade. They have housed a large part of the Nation. Forest industries have afforded a livelihood to millions of individuals and have sustained many thousands of communities. Streams from forest-covered watersheds have given value to millions of acres of irrigated farms and to numerous hydroelectric plants. They have supplied the water for drinking, for sanitation, and for fire protection, without which most of our cities and villages could not exist. In short, our natural forest resources have contributed very largely to our national development and national prosperity.

Nevertheless, we have never taken adequate steps to insure that these resources will be perpetuated. Forest destruction has proceeded almost without restriction. It is still going on. Our forest capital is already so depleted that it seems impossible to continue production at the rate of recent years. Scores of millions of acres that once produced good timber lie idle and nonproductive. Numerous regions, although they have large areas of idle but potentially productive forest land, are dependent upon distant regions for much of the timber that they use. The destruction of forest cover has caused incalculable losses through erosion and silting, and has necessitated the expenditure of hundreds of millions of dollars for dredging channels, constructing levees, and repairing flood damages.

If we are content to do without forests in the future, or to let them degenerate into relatively worthless scrub such as already covers much of the cut-over land, they will leave a void in our national economic structure which it will be impossible to fill. On the other hand, by restoring and maintaining these resources, we can insure that they will contribute largely in the future, as in the past, to the material and spiritual welfare of the Nation.

To do this is one of the major problems before the American people. There is no evidence nor any reason to suppose that it will be done through individual private initiative alone. There is abundant reason to believe that private initiative cannot and will not solve the problem. Only coordinated effort on a national scale, with the backing and leadership of Government, can adequately meet the issue.

Such a plan is here proposed. Compared with programs that have been suggested in the past, it will require large public expenditures. Forest destruction has gone so far that it is too late for hit-or-miss, half-way measures. Such measures would cost far more in the long run, and would accomplish far less, than a broadly conceived plan which coordinates all efforts and which provides for action on a scale commensurate with the magnitude of the task.

Although large expenditures will be required, it should be recognized that a large part represents a nonrecurring capital investment, which will steadily increase in value. The remainder of the costs should be balanced at a relatively early date by direct money income from the forests or through elimination of expenditures which would be necessary if forest destruction should continue. The capital expenditures also can eventually be liquidated through direct and indirect income from the forests. Forest land, no more than farm land or a factory site, cannot be kept productive without adequate investment of capital. The timber capital which was already present in the virgin forests has largely been liquidated or destroyed. If the American people want to have the benefits of forests in the future, they will have to replace a reasonable amount of this capital.

Comparable or, in some instances, much larger public expenditures have been made or are contemplated for other projects. Examples are the reclamation program, the Colorado River development (Hoover Dam), the Panama Canal, the St. Lawrence development, Mississippi flood control, inland and coastal waterways, and subsidies to shipping. Some of these are of much more limited scope and far less national significance than a forestry program. The success of some of them, such as the Mississippi project, will depend to a considerable degree upon the conservation of the forests.

Now is a particularly opportune time for undertaking the forestry program that is outlined. It may even be desirable in the immediate future to go farther than the plan proposes along such lines as construction of improvements and betterment of forest stands. This would give opportunity for a large amount of employment, widely diffused over the country. It would increase consuming power without immediately increasing the output of consumable goods, and would thus help to dispose of existing surpluses. Suitable forest land can be acquired much more easily now than would have been possible in the past, or than may be possible later. Costs of land, materials, and labor are relatively low. As a large part of the expenditures will represent long-time capital investment, and as the major benefits of the program will be realized many years in the future, it would seem that a considerable portion of the cost could appropriately be financed through long-term bonds.

It is important that the program be adopted without delay and carried to a conclusion as rapidly as possible. Nothing is to be gained by procrastination. On the contrary, postponement will mean further forest destruction and consequently will only add to the difficulty of the task and increase the costs. Prompt action will save large areas of forest from destruction, and thus will render unnecessary the costly rehabilitation of these areas. The earlier the work is commenced, the sooner can current losses be stopped, the sooner will returns be received, and the sooner will our forest lands play their proper part in contributing toward the material welfare and the health and happiness of the American people.

THE RESPONSIBILITY FOR FORESTRY

NATIONAL LAND-USE POLICIES AND THEIR RELATION TO FOREST DEPLETION

The depletion of America's forest resources, discussed in previous sections of this report, may be largely attributed to the national conception of the rights of the private citizen and to the policies set up to protect those rights even at the expense of public welfare. That such a situation has developed is readily understandable when we consider the traditional heritage of the Nation.

For 3 centuries America has been regarded as a land of freedom and opportunity. To the New World came millions of settlers who sought to free themselves from political or religious persecution, or from the restraint imposed by economic and social conditions in the Old World. America was the land of golden opportunity for those who had the initiative and the strength to take what they wanted. Rugged individualism was the common characteristic of the men who settled this country. This background explains how the ideals of freedom and unrestricted rights of citizenship became embodied in the American philosophy of government and in American laws and policies.

The country's vastness of area and wealth of resources contributed to similar ideals and policies in trade, business, and industry. The American frontier was extended steadily westward; the early explorers were followed by fur traders and trappers, and these in turn by pioneers seeking fertile virgin lands to clear and cultivate. The development of communities provided opportunities for trade and business. The discovery of mineral wealth and the need for drawing upon new timber resources as those of the settled East became depleted, resulted in the extension of these industries, and, with them, of necessary transportation systems.

This entire movement and development, if the resulting exploitation may properly be called development, has been characterized by a national policy of bestowing extremely liberal property rights on those who appropriated lands and land resources. Since 1785, Congress has donated over 200 million acres of the public domain to the States, and approximately 94 million acres to the railroads, to enable them to raise funds for their development. Little limitation was imposed upon the disposal of these lands, which were for the most part sold indiscriminately to individuals who proceeded to reap a rich harvest. At the same time the Government has given or sold vast areas of mineral, forest, and farm lands to private owners, until approximately nine tenths of the 1,441 million acres of original public domain have been disposed of. Any thought of responsibility for the future, any disposition to conserve a part of these resources was largely submerged by the policies of an enthusiastic young Nation in the process of growing up.

These policies and methods of encouraging settlement and development of new areas and of stimulating the conversion of apparently inexhaustible resources are not matters for unqualified condemnation. They have been justified, in part at least, by results. Never before in history has a nation grown so rapidly in size, in wealth, and in power. It might even be asserted with some justice that the United States of today owes its position in world affairs largely to the result of these same policies. Yet to those who look beyond the present and plan for the future, it is disturbing to note that much of our present wealth is tied up in costly superstructures dependent upon basic resources that have been extensively sacrificed for their development. We have built large cities, powerful institutions, enormous industries, extensive systems of transportation. Our expansion in agriculture has been tremendous. American standards of living are high. But for this we have paid with the exploitation of a large part of our forest and land resources, and in so doing we have definitely mortgaged our national future.

The story of forest and wild-life depletion, extensive land devastation, uncontrolled streams and wasted water resources, eroded and abandoned farm lands, declining forest industries, decadent communities, alarming tax delinquency with virtual bankruptcy of local government in many regions, has all been told in previous sections of this report. It is, of course, obvious that this situation cannot continue if the Nation is to thrive. It is equally obvious that most of these serious ills have been caused directly by the national policy of allowing the private owner of land to exploit its resources at will for his own immediate gain, with few restrictions in the interests of public welfare. Our American assumption has always been that private initiative, through self-interest, would find ways of keeping land productive. We now discover that this same self-interest, together with lack of concern for the public or the future, has caused the ruin of land by the millions of acres. Many owners have disavowed any further responsibility by abandoning their lands to the public as a liability. The Nation is faced with a situation that demands realization and acceptance of responsibility for remedial action.

A NEW ERA BEGINS

While America was still in the expansion stage of development, with abundant resources at every hand, the dangers into which its land policies were leading were obscured by national optimism. We were a free people, with plenty for all. It was easier, and apparently better economy, to cultivate new soils after the fertility of the used areas became exhausted than to maintain soil productivity by more conservative and somewhat costly methods of cultivation. Apparently there was no need to worry about a second crop of timber from cut-over lands, with a cheap and presumably inexhaustible supply of virgin timber at hand. The extensive measures of expansion had nothing in common with the intensive measures of conservation.

Gradually, toward the end of the nineteenth century, a perception of the inevitable outcome of these policies began to develop. In some regions the depletion or exhaustion of resources caused certain individuals to think of the future, and the idea of conservation was born. With the twentieth-century development of transportation and communication, world trade as well as increased local consumption of products speeded up the processes of exploitation, and at the same time better opportunities were provided for observing and appreciating the extent to which these processes had been carried. As a result the demand for conservation became stronger and constructive action began. The creation of national forests, by withdrawals from the public domain, and the establishment of Federal and State forestry organizations were among the first steps taken. Other conservation agencies came into being and gradually extended their influence. However, the progress made by the pioneer foresters was accomplished against difficult odds, and despite public indifference or even antipathy.

Experiences of the World War period and the years immediately following emphasized the national importance of basic resources, and the necessity for conserving and restoring them. As a result forestry programs were strengthened, although during the years of inflated prosperity which followed the war the average citizen was too much engrossed with making and spending money to give much attention to public-welfare enterprises such as conservation. The progress that was made can be credited chiefly to organized minorities of conservationists.

Within our Nation, astonishing contrasts of organization and disorganization have always existed; splendid technical proficiency in some incredible skyscraper is found side by side with distressing backwardness in some equally incredible city slum, a marvelous bridge spans a river of uncontrolled waters, and a modern concrete highway leads through the desolate ruins of a once-productive forest. That such contrasts exist is evidence of the precarious status of our national development.

In 1929 came the depression. Faced with its serious consequences, we have started with characteristic energy to determine the social and economic facts contributing to the situation, and the possibilities for remedial action. The depression has emphasized the necessity for a national inventory of resources such as that of the forest resources which is under way, and the need for a change of policy in their management. This report is a contribution toward facing the facts of the forest situation in this country and its relation to land use and other problems.

THE ACCEPTANCE OF RESPONSIBILITY

In the previous sections of this report the discussions of forest devastation, land deterioration, and related problems have clearly pointed out the failure of individuals or agencies, until comparatively recently and with few exceptions even yet, to assume responsibility for stopping harmful forest practices, or for establishing conservative forestry measures. The inadequacy and ineffectiveness of most of the restorative projects now under way have also been emphasized, together with definite recommendations for new or extended measures considered essential to the solution of these problems. In view of the past policies regarding forest and land use, the exaggerated conceptions of the property rights of the individual, and the general lack of concern over problems of public welfare, it becomes highly desirable to define the responsibility for the measures needed.

Responsibility is the state of being accountable, as for a trust or obligation. It implies dependability. Obviously fulfillment of responsibility cannot exist until one has accepted his obligation. Acceptance may consist of actual agreement, or it may be implied and enforced by legislation. A certain degree of responsibility may be enforced by public opinion, morally if not legally. Responsibility must always be accompanied by authority since one cannot be held accountable for circumstances over which he has no control. When responsibility is assumed, there must be at least reasonable expectation of accomplishment: no one can assume responsibility for the impossible. Recognition of these underlying principles of acceptance, authority, and expectation of fulfillment is necessary to an understanding of the responsibilities of various agencies, public and private, in the national forestry program.

Responsibility, and the authority it carries, may be shifted with changing conditions. In the old horse-and-wagon days, traffic conditions required little or no regulation. Responsibility rested almost entirely upon the drivers of the vehicles. But with the advent of the automobile and the complicated problems of modern traffic, it became necessary from the standpoint of public welfare to enact legislation regulating highway use. The public thereby assumed the responsibility for controlling traffic to the greatest extent legally possible; it could not, however, assume the obligation of preventing all accidents, because of the human factor of carelessness beyond its control. Therefore the responsibility of the individual was also increased, in the assumed compliance with the regulations set up. This is but one of many examples that might be cited to show how new conditions have developed the need for new policies. In many instances the individual must waive his former unrestricted rights for the public good, and at the same time his own responsibilities may increase.

In the management and protection of forests and forest lands, changing conditions have brought new responsibilities. Economic changes involve shifts in responsibility. Growing realization of conditions not formerly recognized in their true significance necessitates entirely new emphasis on responsibilities hitherto unassumed. For many of the recommendations made in this report legal authority definitely fixing responsibility already exists; in other instances we must depend upon the moral force of awakened public opinion in lieu of legislation, or until legislation is enacted.

THE DIVISION OF RESPONSIBILILY

THE PRIVATE CITIZEN

The responsibility of the private citizen in regard to forestry is in part included in those more or less intangible obligations inherent in good citizenship. A good citizen is one who concerns himself with the affairs of his community, his State, and his Nation, and who works in the interest of their permanent stability and well-being. With the complications of modern civilization he cannot give personal attention to all these affairs, so he joins with his fellow citizens in electing competent men to represent him in government. What he and his neighbors think about various matters constitutes public opinion, which dictates the policies of government. In the last analysis, the private citizen is responsible for the control of the country, and the manner in which its resources are managed. If he neglects to take an intelligent personal interest in affairs of outstanding importance, or if he fails to choose able representatives, he cannot expect good government. The extent to which conservation policies are followed in the management of the Nation's forest resources depends directly upon public opinion.

THE PRIVATE LANDOWNER

The forest owner has the responsibility of good citizenship as well as the obligations which accompany ownership. The owner is actually a custodian of the land; to him his ownership may seem permanent, but after all it lasts only for a very brief period of time as reckoned in the life of the Nation. During his custodianship he has no moral right to destroy the land's permanent productivity; future generations must depend upon it for a livelihood, and the prosperity of the Nation is based upon the perpetuation of its resources.

Ownership is an important factor in the determination of responsibility for forestry, because ownership carries with it certain definite obligations, usually involves at least partial acceptance of responsibility through self-interest, and provides some degree of authority for control. Responsibility for forestry measures by no means rests upon ownership alone, however, especially under the present conditions of maladjustment due to past land policies. In many instances the owner lacks the authority to perform certain acts necessary to safeguard and develop his property. He may lack any incentive to do so, and there may exist neither legislative authority compelling him to accept legal responsibility, nor public opinion compelling him to accept moral responsibility. Or, if he has the incentive, he may lack the financial means to assume obligations with any expectancy of accomplishment. Furthermore, the owner may be entirely unable to benefit from certain values that his property holds for others, or for the public in general, in which case the other beneficiaries may reasonably be expected to share the responsibilities, or perhaps to relieve him altogether of some of them. This situation is frequently encountered in the case of private forests having great importance for watershed protection. Regardless of extenuating circumstances, however, ownership of forest land carries with it definite obligations for productive use.

THE PUBLIC

When private owners of forest land cannot accept, or can successfully evade, the responsibility for certain measures essential to public welfare, it is self-evident that the public must assume it. Public resopnsibility is governed by the same principles and subject to the same limitations that control the acceptance of responsibility by private owners. Although decentralization of government and dependence as far as possible upon local self-government is a well-established American policy, in many instances local government has neither the authority, the incentive, nor the means to assume new obligations. In spite of tradition, changing economic trends are compelling us to form new conceptions of the organization and functions of local government. In instances where responsibility for essential forestry measures cannot be assumed locally, it must of necessity be passed on to larger governmental units. Thus responsibility for certain measures is taken over by the States, or, when circumstances prevent their functioning, by the Federal Government. Ample justification for this sharing of responsibility is found in the fact that these measures are essential to public welfare and national prosperity. Critical conditions demand the utmost participation by every agency capable of contributing aid.

There are two ways in which responsibility may be fulfilled, both of which are recognized and well established by precedent in most important enterprises of national scope. In some instances a certain agency—the private owner, or the local, State, or Federal government, as the case may be—assumes complete responsibility for certain activities which it alone is best able to carry out. Examples are the Postal Service of the Federal Government, and the police and fire protection of municipalities. In other instances, where the interests of many agencies are involved, cooperative sharing of responsibility may best be accomplished through assumption of authority by a single agency, with financial or other support from all interested parties. Precedent for this is found in the cooperative financing of highway construction, to which local, State, and Federal Government contribute, more or less in proportion to the extent of the local or general public interests involved.

Both these modes of sharing responsibility are embodied in the forestry programs now being carried on in this country, the expansion of which is proposed in this report.

THE PRIVATE OWNER'S PART

RESPONSIBILITIES

About 80 percent of the commercial forest land and 59 percent of the saw timber is now in private hands. Of the private land 32 percent, and of the stumpage 12½ percent is owned by farmers, the remainder is chiefly in industrial ownership.

For many years the Federal and many State governments have tried to make it possible for private owners to retain their forest lands and to keep them in productive condition. The public has extended financial and other aid in many forms and in fairly large amounts to the private forest landowner. It has refrained from asserting in any sweeping manner, its presumable legal power to regulate the use of private property so as to prevent injury to the public interest. It has assisted both by what has and has not been done, and has generally left the private owner a free hand in the management of his property.

This program has failed to halt destructive treatment of private forest lands. Whatever the reasons for continuing depletion, both the public interest in productive lands, and the private interest in the perpetuation of natural resources as a source for private business have suffered markedly. The program has even failed to keep all forest land in private ownership, as the continuing abandonment through tax delinquency testifies. This report estimates that perhaps 162 million acres of private commercial forest land will eventually be transferred out of private and into public ownership, much of it because it has deteriorated to the point of lack of opportunity in timber growing.

This report proposes that public agencies continue aid to private forest landowners on an increased scale. It proposes that the lands unattractive to private ownership be acquired and managed as public forests. It proposes no immediate country-wide attempt to regulate the use of private forest land. It proposes the extension of Federal credit at low interest as a means to stabilize individual forest business. It proposes to take over the overloads of private stumpage which are forcing overrapid liquidation and cut-throat competition. Back of all these and other proposals, is frank recognition of the fact that forestry on private lands must have a chance to yield profits comparable to those to be made on other classes of investments involving similar risks.

The report proposes, in short, to leave to private ownership some of the best of the opportunities to practice industrial forestry, unencumbered by regulatory costs or by poor or depreciated forest lands. The report proposes that the public interest in all but a part of the better private lands be protected through public ownership, with complete assumption of costs.

These proposals aim to get at the real basis of many of the immediate ills of the forest-products industries, and to leave to private ownership the opportunity to perpetuate itself and redeem the public interest through:

(1) Rational treatment of forest land.

(2) Planned and orderly utilization of forest products.

The report thus assumes that as public action leaves to private ownership a genuine industrial opportunity, intelligent self-interest will lead to acceptance of it. A transition period will necessarily be required for final stabilization of ownership everywhere. But when the suggested realinement of ownership is completed, private ownership is counted on to produce 50 percent of the timber required to balance the national timber budget.

The program for private owners assumes that approximately 261 million acres of commercial forest lands and 32 million acres of abandoned agricultural lands will be owned and managed by the public; and 234 million acres of commercial forest lands and 23 million acres of abandoned agricultural lands by private owners.

ACTION REQUIRED

In the assumption of responsibilities, the owner of private forest lands must follow certain essential lines of action:

(*a*) He should concentrate his holdings on a productive acreage. The use of marginal lands invites failure; the use of submarginal land assures it.

(*b*) He should use all of his land, but must not abuse it.

(*c*) He must protect his forest property from fire and the ravages of insects and disease. This is largely his responsibility, although the public, because among other things of its stake in his enterprise, will carry a part of the cost. He is expected to carry 25 percent of the total cost of adequate fire protection, except as States finance the non-Federal share; building up to an eventual annual total private expenditure of $5,000,000.

(*d*) He must reduce to the minimum the avoidable waste of his resource in harvesting the cut and in the primary manufacture of the products.

(*e*) He must build up and maintain a sufficient growing stock on his property and must so regulate his harvesting as to remove the accumulated growth with no depletion of his forest capital. Any other line of action will lead inevitably through impoverishment to eventual devastation. The acceptance by all owners of this responsibility would include planting 5,755,000 acres in the next 20 years, and would add to the intensively managed forest area at the rate of 1,500,000 acres a year.

(*f*) He must carry on such local or special research as may be required to develop his property and its business most profitably.

(*g*) He must, through organized effort in the form of trade associations or otherwise, develop markets for his products, perfect methods of distribution, and extend and strengthen his financial structure and credit facilities.

Private owners of forest land are numbered in the millions, are distributed throughout all forest regions, are highly individualistic in thought and action and their problems of forest technique, of utilization, of marketing, and of financing are many, varied, and complex. In general, private forest owners do not today play their part in the national effort as organized groups. It must be expected that great differences in responsiveness to such a program will be found as between individuals and regions.

To carry out acceptably their part in the national program, it is highly desirable that private owners develop greater industrial solidarity, and organize for greater strength both within and for the group as a whole. The growers of wood today are as highly individualized as any industry in the country and have suffered greatly in consequence. Their customers, their competitors, their financiers, and their distributors are, in the main, well organized to protect and advance their own interests. United action will be necessary to provide for extension of uses, in markets and in facilities. Adequate protection from fire will require cooperative effort. The American industry that operates like a confused scattering of feudal barons, each man for himself, is fighting against tremendous odds.

COSTS AND RETURNS

It is estimated, to bring the Nation's forest production power up where it can satisfy the 16½ billion cubic feet of possible normal requirements, that 40 million acres of privately owned forests must be put under intensive management and 150 million acres under extensive management. The cost of handling forests under intensive measures of protection, timber culture, and regulation, including taxes but not interest on investment, will vary from as little as 37 cents per acre per annum in the southern pine region to as much as $1.13 per acre annually in the Northeast. Extensive management will cost less.

The possible gross returns from intensive management, including timber commodities only, will range from $1 per acre per annum in the southern Rocky Mountain forests to as high as $3 per acre per annum in the South. The returns from extensive forest management may vary from about 37 cents per acre per annum in the southern Rocky Mountain region to $1.20 in the South.

When the program is completed to the extent that 40 million acres of privately owned forests are under intensive management and 150 million acres are being given extensive management, the gross value on a stumpage basis of the production may approximate $440,000,000 per annum, for timber products alone. The cost of taxes and cultural and protective operations is not likely to exceed $100,000,000 annually, thus leaving private owners $340,000,000 annually as a margin for interest on their investments.

FINANCING THE PRIVATE OWNER

If and when the program has been developed to the point shown above there will be no question as to the ability of the private forest owner to finance his operations. It is during this period of development that the subject of financing needs examination.

So far as the industrial forest operator is concerned, the enterprise is and will continue to be a strictly business one, subject to well established laws of accounting and financing. The farm woodlot owner will manage his forest in conjunction with his agricultural operations wherein the woodlot becomes one of several diversified crops. With him the question of financing is more than likely to be absorbed in the larger field of agricultural finance.

In the section "Federal Aid in Organizing Forest Credit Facilities," it is brought out that the present probable total borrowed capital in forest industries approaches $1,000,000,000 but that this borrowing has been for manufacturing purposes rather than for care and perpetuation of forest productivity, and that the latter purpose is not adequately provided for in the present scheme of things. The problem ahead for industrial forest owners is to gain access to sufficient capital at interest rates and at terms suitable for their purposes. Capital will be needed for the measures designed to improve the productivity of original forest units, including timber cultural and stand reinforcement operations; to assist in the orderly marketing of timber already mature; to allow the purchase and assembly of tracts for organized forestry units; to construct necessary transportation facilities; and to construct required manufacturing plants.

It is difficult to gauge just how much borrowed capital will be needed, but it is certain that the amount will be so large and the requirements as to favorable terms and rates so out of the ordinary as to raise serious doubts as to the possibility of obtaining it from the usual sources of commercial credit. The development of the business of growing continuous crops of timber expected under such a program as is set out here will in time create sources of borrowed money at favorable terms, but until such a basis is established it appears that Federal aid in organizing forest credit facilities will be necessary. The section referred to suggests a thorough study of a plan to meet this need by the establishment of organized institutions to provide forest credit under the Farm Loan Board.

With the various forms of public aid proposed, and with acceptance of the genuine opportunities on the better private land, private owners should be able to carry the timber growing program that is left to them.

THE PART OF QUASI-PUBLIC INSTITUTIONS IN FORESTRY

Occupying a position in the field of forestry which may not properly be classified as either private or public are a number of agencies represented in part by the privately endowed universities and scientific institutions engaged, usually as only a part of their activities, in forestry education or research in forestry and related subjects. These institutions, although independent of governmental control and of legislative financial support, have certain public aspects which distinguish them from private endeavor in the usual conception of the term. They are more public than private in the sense that they are not operated for profit and that the services which they render are directed at the advancement of the public welfare and are generally available to everyone. Such institutions are in a position to render a distinctive service in the national forestry program, especially in working for the solution of basic technical and economic problems in which action should be unhampered by pressure for either profit or immediate results. The forest research activities of the principal educational and research institutions which come under this heading have been discussed in the section "Privately Supported and Quasi-Public Forest Research."

The principal responsibility of the forest schools and other departments of colleges and universities referred to in this section is, of course, education—first, the professional training of men to carry on the national forestry program and second, general education related to forestry which will broaden public understanding and appreciation of the significance of forestry in the national economy. These educational institutions have a further responsibility which is inherent in their opportunity to assist in the molding of public sentiment toward forestry and in the framing of public forest policies. In this as well as in their strictly educational functions, these agencies can make a very substantial contribution through the development and management of demonstration forests, such as those maintained by Harvard, Yale, and Duke Universities. Because of their neutral position, free from the profit motive on the one hand and from political incentives on the other, these endowed educational institutions may well continue to assume aggressive leadership in suggesting and working for desirable State and National legislation dealing with forestry.

Finally, these institutions have an important responsibility and opportunity for service in the field of forest research. In this field the forest schools and universities are joined by the independent endowed research institutions and arboreta, such as the Carnegie Institute of Washington, the Boyce Thompson Institute for Plant Research, Inc., the Mellon Institute of Industrial Research, Institute of Forest Genetics, the Arnold Arboretum, the Missouri Botanical Gardens, the New York Botanical Gardens, etc. All these agencies are in an especially advantageous position because they are free to undertake the study of any phase of technical forestry or the basic sciences which underlie it. Their efforts may well be directed at fundamental problems of tree growth, tree breeding, or basic economic problems which for one reason or another may be neglected in the programs of other agencies.

In the national programs the activities of institutions of this sort should be given every possible encouragement. Their work might well be supplemented by a separate institute endowed specifically for forest research as suggested in the section "A Program for Forest Research." No specific financial program can be set up for these institutions, beyond an estimate that the establishment of the proposed forest research institute might require an annual income of $1,000,000.

Aside from the educational and research institutions a forest credit agency such as that suggested in the section "Federal Aid in Organizing Forest Credit Facilities," if established, would constitute a quasi-public institution which might play an important part in stimulating private forest management on a large scale. Although it is contemplated that it is a Federal responsibility to organize and provide the initial capital, it is believed that such an agency, once started, should function as an independent self-supporting institution operating under a broad legislative charter but not under direct political control in any way. No specific financial program for such an institution is suggested as the scope and characteristics of the undertaking should first be given additional study.

In the category of quasi-public institutions are also the forestry and conservation associations which have had such a large part in the formulation of public opinion, in the passage of desirable legislation, and in defeating undesirable legislation. The opportunity for the representation of groups of public-spirited citizens in constructive action will be as great in the future as it has been in the past.

THE PART OF THE STATE AND LOCAL GOVERNMENTS

It is undesirable to attempt, in this report, to propose a definite forestry program for each individual State, since that is properly the function and privilege of State authorities. In order to develop a coordinated program for the Federal, State, and private agencies, however, it is necessary to estimate the combined responsibilities of all State and local governments.

It is difficult and perhaps unnecessary to distinguish sharply between the efforts of State government and those of local government.

Both have certain responsibilities, arising from local public needs. It is assumed that local government should accept its obligations to the full extent of its legal authority and financial ability, but that usually a large degree of responsibility for the local forestry program will rest upon State government. Unless specifically explained otherwise, therefore, the term "State" as used here will refer to the combined public agencies within the State.

RESPONSIBILITY OF THE STATE

The forestry responsibility of the State is divided into three major fields:

(1) State-aid activities to promote and encourage private forestry; (2) research in forestry and related problems; (3) acquisition and administration of forest lands.

State-aid activities consist of participation in the protection of privately owned forests; production and distribution of trees for forest planting; projects of forestry extension and education; enactment and enforcement of legislation; and general advisory services.

State research in forestry and related problems includes coordinated investigations calculated to supply much of the information needed as a basis for local forestry measures. Research contributes to State-aid activities as well as to State forest management.

When a State adopts a program of forest ownership it assumes financial responsibility for forest-land acquisition and administration, and responsibility for permanently managing its lands in the best interests of the public. Such management includes intensive silvicultural practice for sustained timber production; protection against forest fire and other injury; reforestation, where necessary; and satisfactory measures to safeguard watershed, wild-life, recreational, and other forest values.

In setting up the State forestry program which follows, allowance has been made for the greatest expansion of private forestry that can reasonably be expected. Due consideration has been given to the economic requirements and limitations of the local forest situation, and to State ability to accept further financial or other obligations. Federal participation has been assumed to the extent that the private and State programs leave forestry obligations unprovided for. Therefore this program outlines the greatest participation that can be expected from the States, and at the same time the least responsibility that can be considered their share.

This section summarizes conclusions stated in greater detail in the program sections of the report.

THE STATE FORESTRY PROGRAM

THE ORGANIZATION NECESSARY

In 42 States legal provision has been made for forestry activities of one kind or another, yet in relatively few has progress been commensirate with the forestry problems. Failure in achievement has been caused either by inadequate funds, insufficient authority, unstable policy or organization, or political restrictions or by a combination of these circumstances, all of which reflect lack of intelligent interest on the part of the public.

To meet its responsibilities, a State forestry organization must have permanence, stability, authority, and freedom from political interference. Its policy must be sound and comprehensive; its financial support must be adequate and sustained. Its staff must be composed largely of technically trained men of high ability and sincerity of purpose. Lacking any of these essentials, it will inevitably fail to achieve the objectives for which it should strive.

Some few States now approach these requirements for forestry organization, and are making satisfactory progress consistent with their past conception of their problems; but if they accept the responsibilities of the forestry program now conceived to be necessary, they will have to increase their efforts very considerably. Other States fall far short of meeting the desired standards of forestry organization, in many particulars. The only remedy lies in further legislation, sponsored by awakened public opinion. No State can hope to fulfill its forestry responsibilities without a strong organization.

THE PROGRAM FOR STATE AID IN FORESTRY

The program for State aid in forestry differs in the various States, just as forest problems vary in importance between regions. However, uniformity of attack by the individual States has been greatly increased through Federal cooperation in State-aid activities. The magnitude of the forest problem necessitates a very considerable expansion of the State-aid program.

PROTECTION OF FORESTS FROM FIRE

State responsibility for protection of forests from fire is generally recognized, yet the States are providing organized protection for only 227.6 million acres, or 54 percent, of the 420 million acres of State and private forest lands estimated to require it. It is estimated that the annual cost of adequate fire protection for State and private forest lands will ultimately amount to $20,000,000. State fire-protection activities should be expanded in the immediate future, with financial aid from the Federal Government and in cooperation with private landowners, to cover the entire area of State and private forest lands requiring organized fire protection. For this reason early increases are programmed in State fire-protection expenditures, including needed capital investments.

This (10-year) program contemplates an increase in State funds for fire protection to $6,342,000 by 1944, with annual appropriations averaging $4,391,000 for the 5 years 1935–39 and $5,762,000 for the five years 1940–44. In 1932 all State expenditures for fire protection amounted to only about $3,565,000.

PROTECTION OF FOREST FROM INSECTS AND DISEASES

The States should take a leading part in the control of injurious forest insects and forest diseases, through cooperation with Federal agencies in detecting infestations and epidemics, in inspecting nurseries, and in enforcing necessary quarantines and other regulations.

During 1932, approximately $1,320,000 was expended by the States in forest-insect control. It is predicted that some increase in that sum may be necessary within the next 5 years; unless extreme emergencies occur, however, it is not anticipated that the total State contribution needed in any one year will be in excess of $1,500,000.

During 1932 State and local governments spent approximately $246,000 in the control of forest diseases, the major expenditures being for control of the white pine blister rust, which attacks all the 5-needled pines. In order to cope fully with the disease problems that now exist, it is estimated that State appropriations should be increased to $695,000 by 1939. Undue delay in the application of disease-control measures may result in severe losses of valuable timber.

PRODUCTION OF PLANTING STOCK

The production of nursery stock for private tree planters is an important State-aid project. In the program of forest planting presented in this report it is recommended that at least 5.7 million acres of privately owned lands be planted with forest trees within the next 20 years, at the rate of 285,000 acres per year. This represents practically twice the present rate of planting by private and public effort combined.

The planting of 285,000 acres annually, at the rate of 1,000 trees per acre, requires an average annual State nursery production of 285 million trees. It is estimated that for the first 10 years the total cost of producing the nursery stock required will amount to $1,100,000 annually. With the purchase of trees by private planters at half the cost of production, and with a Federal-aid contribution of 25 percent of the expense, the net expenditure by the States during the first 10 years would amount to $275,000 annually. A considerable additional State nursery production would be required to grow the trees needed for planting State forest lands. Since the development of adequate planting stock is essential to carrying out the proposed planting program, planting-stock production should be greatly expanded in the immediate future.

FORESTRY EXTENTION

The dissemination of forestry information to forest-land owners and to the general public is one of the most effective means of bringing desirable forestry practices into application upon the widely scattered private forest-land holdings, and is a highly important cooperative project of Federal and State government. The contribution of the States to forestry extension is notoriously inadequate as compared with other forms of State aid; in 1932 the expenditures of all the States for this purpose totaled $108,000. The forestry extension services of the States are for the most part limited to farm forestry. Together with the need for greater forestry extension service for farmers, there exists a great need for more extension among other classes of forest owners. It is estimated that State funds available for these activities should be increased to not less than $400,000 a year.

FORESTRY EDUCATION

The States have assumed the major responsibility for forestry education. Nineteen State universities and colleges are now conferring degrees in forestry, and many others are giving limited forestry training to agricultural and other students. It is estimated that approximately $967,000 is now expended annually by the States for forestry education. Some institutions give comprehensive professional forestry training, while others lack sufficient personnel and facilities to do this. The general need is for better rather than more professional forest schools. All institutions of agricultural education should provide at least general and elementary courses in forestry, especially for students training to become teachers or extension leaders in agriculture.

The recent forestry education inquiry conducted under the auspices of the Society of American Foresters led to the conclusion that the minimum annual budget of a satisfactory forest school is between $35,000 and $45,000. It is estimated, therefore, that an annual expenditure of at least $1,200,000 by State educational institutions will be needed to bring about the increased and improved forestry instruction here proposed.

FOREST RESEARCH

The greatly enlarged program of direct State forest-land management and administration and of State aid to private forest-land owners which this report recommends calls for a very great expansion of State forest research. This expansion should be effected in the immediate future.

The field of State research in forestry includes local problems of forest establishment, regeneration, protection, management, and utilization, and also some of the more fundamental problems affecting forest-land resources. Studies may be conducted independently or in cooperation with Federal agencies. There is special need for State research to obtain more accurate information concerning forest resources and forest-land use, and for State studies of forest taxation.

At the present time the States are not conducting forest research on a scale at all comparable with that of the Federal Government; in 1932, State agencies expended altogether approximately $429,000 for research in forestry and related activities. This includes the expenditures of the State forestry departments, the State forest schools and agricultural experiment stations, and local public agencies. Within the next 10 years the funds provided for forest research by these agencies should be increased to at least $2,500,000 a year.

PROGRAM FOR STATE OWNED FORESTS

PRESENT AREA AND ADMINISTRATION

Some 16 million acres of forest lands are owned or being acquired by State and local government at the present time (1932). This area includes 405 State forest units under administration in 30 States, with a total area of 4,395,549 acres, and 2,231,636 acres in the process of acquisition as State forests. It includes 2,682,509 acres of State parks composing 323 units in 28 States, nearly 1,000,000 acres of county and municipal forests, and approximately 6,000,000 acres of State-owned forest lands not under administration. In addition, tax-reverting forest lands for which State or local governments have not yet recognized responsibility are estimated to total from 20 million to 30 million acres in three important forest regions alone. Obviously, one of the first requirements of State forestry is to place these public forest lands under permanent management.

ADMINISTRATIVE PROVISIONS NEEDED

The 6 million acres of State-owned forest lands not under administration are scattered through all parts of the country, but the major areas are located in the West. These consist largely of Federal grants of forest land which the States have not placed under administration, or for which present State policies of administration fail to insure satisfactory permanent forest management. In many instances the unadministered State lands consist of scattered sections which should be blocked together by land exchange, or built up into sizable administrative units by further acquisition. The determination of logical administrative units and the blocking of State-owned forest land, as far as practicable, into such units, is of immediate importance in obtaining effective State-forest management and administration.

In addition to the estimated 20 to 30 million acres of tax-delinquent and abandoned private forest lands already reverting to the public, there is little doubt that involuntary public ownership is pending for a much larger forest area. In some States title to tax-reverted land is vested in the county or local government; in others, in the State itself. In all instances, solution of the forest problem represented by these lands requires a recognition of public ownership responsibility, and legislative authority for placing the lands suitable for public management under permanent administration by the most appropriate public agency. Provision should be made for returning to private ownership those lands better suited to private than to public ownership and administration.

The classification "State-owned forest lands" includes State forests, parks, game refuges and other wild-life areas, county and municipal forests and parks, and institutional forest lands. Many departments of State and local government participate in the administration and cooperate in the management of these lands. Certain of these areas have chiefly local values; others provide widespread benefits. The interest of public efficiency and economy is best served when all efforts connected with administering State-owned forest lands is closely coordinated under the leadership of a State forestry or conservation department.

STATE ACQUISITION OF FOREST LANDS

State forests have been defined as areas specifically set aside or established by legislation contemplating their permanent retention and administration by the State for forest purposes and organized in definite administrative units. Under multiple-use management State forests may provide a variety of local benefits and uses, and at the same time contribute very greatly to the forestry needs of the State and Nation. To meet the requirements of a satisfactory national forestry program, it has been estimated that the States should acquire 90 million acres of land for State forests. Of this total, 70 million acres should be acquired by the States east of the Great Plains, and 20 million acres should be acquired by the Western States. The area proposed for acquisition is approximately nine times the area of the State-owned forest lands now under administration.

A considerable portion of this total area will undoubtedly come into State ownership through tax delinquency, as sizable areas have already done in some regions. The total expense of this State acquisition program is estimated at $224,000,000 in the East and $32,000,000 in the West, on the basis of the assumption that the costs per acre will average $3.23 and $1.60 in the two regions, respectively.

Approximately 10 million acres of State forest lands are now under administration, and the acquisition program here suggested contemplates a total of 100 million acres at the end of 20 years. An average rate of 5 percent of the total program per year is recommended, as in the case of Federal acquisition, with equal progress in the East and in the West. This would add 4.5 million acres per year to the State forests, at an expense of $12,800,000 divided among the States participating in the program.

In some instances the present condition of State finances may prevent immediate initiation of an acquisition program of this size; in many States the immediate requirement is legislative authority for permanent public ownership and administration of the millions of acres of abandoned and tax-reverting forest lands, and of the State-owned forest lands not under administration at present. The use of public funds for the constructive development of forest resources is recognized as a productive undertaking that may contribute greatly to unemployment relief during the present emergency.

ADMINISTRATION AND MANAGEMENT OF STATE FORESTS

The purposes, uses, and benefits of public forests, as well as their management, have been thoroughly discussed in other sections of this report. Here it is sufficient to state that the costs of acquiring and administering such forests may be partly balanced, and in some instances exceeded, by the ultimate cash returns from their management, not to mention the great although more or less intangible values that accrue to the public in watershed protection, stream flow and erosion control, wild-life perpetuation, recreation, and community development.

Cost data pertaining specifically to State forests are not available. Experience in administering the national forests has shown that public forests may require a capital investment of $2 per acre for administrative improvements such as buildings and transportation systems and for cultural measures of silvicultural management and reforestation. An additional charge of about 10 cents per acre per year is required for protection and current management expenses. On this basis, for the 4.5 million acres of State forests to be acquired annually the average capital investment would amount to about $9,000,000 and the current administration expenses to about $450,000.

Although much of the land to be acquired for State forests is now tax delinquent, in establishing State forests it is often necessary to provide some financial return to the local tax unit for lands withdrawn permanently from taxation. This is taken care of in part by relieving local government of certain improvement or maintenance costs, as for roads. In some States a fixed sum is paid annually to the local unit in lieu of taxes; in others a certain portion of the annual income from the forest is paid, as is done in the case of the national forests. In many instances an equitable arrangement may consist of a plan combining all these methods.

REFORESTATION ON STATE FORESTS

The reforestation program suggested in this report calls for planting some 13 million acres of State-owned forest land within the next 20 years. This estimate is based chiefly on the proposed State acquisition of lands upon which erosion control and watershed protection are highly important. Planting cannot proceed at a satisfactory rate until the supplies of planting stock annually available are greatly enlarged. This phase of the work should be carried forward rapidly in the immediate future.

To plant 13 million acres in 20 years means annual planting of 650,000 acres. This would require approximately 650 million trees yearly.

It is estimated that the expense of growing the trees and planting them on State forest lands will average $7.60 per acre. The expense of planting 10 percent of the total area of State forests to be acquired, or approximately 10 million acres, is carried in the $2 per acre capital investment. To plant the remaining 3 million acres estimated to require planting will necessitate an expenditure of $1,140,000 annually throughout the 20-year period.

NEEDED LEGISLATION

The development of the State forestry recommended in this program is dependent to a great extent upon legislative action. Specifically, legislation is needed for the following purposes:

1. To provide for the establishment of a strong, efficient forestry organization in each State, with ample provision for permanence, stability of policy, adequate financial support, necessary authority, and freedom from political interference. Where such an organization does not now exist, its establishment is the first essential of the State's forestry program.
2. To provide authority and funds for the proposed State land-acquisition program.
3. To provide authority for permanent State or local ownership of tax-reverted forest and submarginal agricultural lands suitable for State or local management and administration for forestry purposes.
4. To provide authority for consolidation, management, and administration of State-owned forest land, such as grant and tax-reverted land, suitable for these purposes.
5. To provide authority for land exchange to facilitate consolidation and administration of State-owned forest land.
6. To provide the authority and funds necessary for State organization and direction of State-wide forest-fire control, including reasonable safeguards for the legitimate use of fire in the woods and provisions for the punishment of carelessness, neglect, or arson.
7. To provide the authority for organization, the funds, and the regulations necessary for the protection of forests against damage from insects, diseases, acts of trespass, and other injury. In some instances public interest may require the regulation of certain phases of the management of private forest lands.

8. To provide the authority and funds necessary for the expansion of other State-aid functions herein discussed, including forestry extension services and the distribution of forest planting stock to forest-land owners other than farmers, and for the expansion of forest research.

9. To provide for equitable taxation of forest lands as rapidly as sound tax systems can be devised.

10. To authorize the establishment of national forests, where such legislation does not now exist, in States where Federal participation in forest ownership is desirable or necessary to meet the requirements of the national forestry program.

ESTIMATE OF STATE EXPENDITURES REQUIRED

STATE AID AND FOREST RESEARCH

In table 1 is given an estimate of the expenditures by State and local government agencies needed to carry out the State-aid and forest-research programs. For many items the State funds may be supplemented by Federal and private financial contributions under the cooperative arrangements previously described. Approximate expenditures for 1932 are given by way of comparison. Expenditures are given for 5-year periods beginning with the fiscal year 1935, since it is estimated that the immediate program cannot get under way before that year.

TABLE 1.—*State and local government approximate expenditures involved in the State-aid and forest-research programs*

Project	Expenditures in 1932	Average annual expenditures in the 5 years 1935–39	Expenditures in 1940	Average annual expenditures in the 5 years 1940–44	Expenditures in 1945	Average annual expenditures in the 5 years 1945–49	Average annual expenditures in the 5 years 1950–54
	Thousands of dollars	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*
Fire protection	3, 565	4, 391	5, 182	5, 762	6, 342	6, 594	7, 518
Insect protection [1]	1, 320	1, 410	1, 500				
Disease protection [1]	246	600	695				
Planting-stock production [2]		175	200	237	275	300	335
Extension	108	250	390	395	400	400	400
Education	967	1, 034	1, 100	1, 150	1, 200	1, 200	1, 200
Forest research	429	945	1, 465	1, 980	2, 500	2, 500	2, 500

[1] Expenditures not estimated beyond 5-year period.

[2] Estimates of expenditure for planting-stock production do not include any expense involved in production on the present basis, since in general the planting stock now distributed from State nurseries is sold by the States at cost. Nursery expense for State forest planting is, of course, not included in this table.

STATE FORESTS

In table 2 is given an estimate of the expense to State and local government agencies under the program of forest acquisition and administration. The table includes the entire program, estimated to be completed in 20 years.

TABLE 2.—*Estimated areas, and State and local government expenditures, involved in 20-year program of State forest acquisition and administration*

	First year	Second year	Third year	Fourth year	Fifth year	Tenth year	Fifteenth year	Twentieth year
Areas,[1] in millions of acres:								
Acreage to be acquired each year	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Acreage to be acquired by end of year	[2] 14.5	19.0	23.5	28.0	32.5	55.0	77.5	100.0
Expenditures, in millions of dollars:								
Capital investment for improvements and cultural measures [3]	1.80	5.40	7.20	10.80	14.40	18.00	1.00	1.00
Additional capital investment required for planting	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Current expenses for protection and management, at 10 cents per acre	1.45	1.90	2.35	2.80	3.25	5.50	7.75	10.00
Total improvement, cultural, protection, and management expenditures, capital and current	4.39	8.44	10.69	14.74	18.79	24.64	9.89	12.14
Annual expenditures for acquisition [4]	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80
Total expenditures for acquisition at end of each year [4]	12.80	25.60	38.40	51.20	64.00	128.00	192.00	256.02

[1] The areas covered by the acquisition program total about 90 million acres.

[2] Includes 10 million acres of State forests now under administration.

[3] The program calls for a major capital investment for improvements and cultural measures amounting to $2 per acre of the total area to be acquired. The portion of this investment to be made annually increases to 10 percent in the seventh year and continues at that level through the thirteenth year. Additional capital investment of $1,000,000 for these purposes is allowed for annually thereafter.

[4] Since areas acquired in the first few years may consist largely of tax-reverted lands, the actual expenditures for this period may be less than those shown here.

Expenditures for acquisition have been based upon estimated average costs of $3.23 per acre for 70 million acres in the East and $1.60 per acre for 20 million acres in the West, these rates allowing for gifts, for purchase at nominal prices, and for the low cost of acquiring tax-reverted lands.

The estimates of a capital investment of $2 per acre for improvements and cultural measures and a current expenditure of 10 cents per acre for protection and management were based upon national-forest experience, the necessary data not being available for State forests. It is expected that the major capital investment for administrative improvements and cultural measures will start more slowly than acquisition but will eventually outdistance it as purchase areas are blocked out and will come to an end in the thirteenth year. Through the remainder of the 20-year program the expenditure for these purposes is estimated at $1,000,000 annually. Since the State program calls for reforestation of 13 million acres and there are 3 million acres of State land, the reforestation of which is not covered by the $2 per acre capital investment, an additional capital investment of $1,140,000 annually is required. The capital investment for the 10 million acres of State forests now under administration is assumed to be complete.

SUMMARY OF STATE EXPENDITURES

Table 3 summarizes the estimated average annual expenditures for a 20-year program of State forestry, by current expenses and capital investment separated into four 5-year periods.

The State and local government expenditures here proposed for forestry shrink in significance when it is realized that the total forestry expenditures proposed for the next 10 years constitute only 5 percent of the sum which the State and local governments spent on their improved-highway programs during a recent past decade. When it is realized that the $25,000,000 annual forestry expense of the future may ultimately be returned many fold through income from properly managed State forests alone, not to mention less tangible values or the great increase in the productivity of private forests through State aid, the expenditures proposed appear as investments rather than as expenses.

TABLE 3.—*Summary of estimated average annual expenditures by State and local governments involved in 20-year program*

Type of expenditure	First 5-year period 1935–39		Second 5-year period 1940–44		Third 5-year period 1945–49		Fourth 5-year period 1950–54	
	Current expense	Capital invest-ment	Current expense	Capital invest-ment	Current expense	Capital invest-ment	Current expense	Capital invest-ment
	Thousands of dollars	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*
Cooperative State aid	7,800	--------	10,000	--------	11,000	--------	12,000	--------
Forest research	945	--------	1,980	--------	2,500	--------	2,500	--------
State-forest acquisition	--------	12,800	--------	12,800	--------	12,800	--------	12,800
State-forest administration, protection, and management	2,350	9,040	4,380	18,420	6,620	12,340	8,870	2,140
Total	11,095	21,840	16,360	31,220	20,120	25,140	23,370	14,940

THE PART OF THE FEDERAL GOVERNMENT

THE FEDERAL GOVERNMENT'S RESPONSIBILITY

This report has developed the view that responsibility for maintaining and developing the productivity and values of forest lands is an attribute of all classes of ownership. As an owner of forest land the Federal Government necessarily has this responsibility, which in the main has been accepted.

But, because it is the central Government, it has additional responsibilities not contingent upon ownership. Preservation or restoration of forest-land values is a national necessity in order to maintain and develop the national basic wealth represented by forest lands which gives opportunity for the productive use of capital, and thereby serves as a source of employment for labor. It is a form of national defense.

The Federal responsibilities do not necessarily represent the size of the Federal Government's participation in the job, which is dependent very largely on the ability of the States and private owners of forest land to do the full job that needs to be done. Active Federal participation varies in ratio to the degree that the national interest in forest land values is protected under the ownership of other agencies.

Because of widespread depreciation of public values on private forest lands, and because the States have been unable to halt destructive practices or to restore values on the large accumulated area which is definitely unattractive to private ownership, the active Federal participation must increase if the full job is accomplished.

Criteria which have been used in this report to mark the need for a Federal program of action far greater than previously envisaged, include the following:

1. The serious depletion of usable supplies of timber, and the inadequacy of growing stock needed eventually to balance consumptive needs.
2. The widespread deterioration of watersheds through misuse of the forest cover.
3. The failure to maintain and develop essential recreational and wild-life values of forest lands.
4. The widespread breakdown of private ownership of forest land, and the threat of an accelerating rate of abandonment.
5. The rapid increase in the area of abandoned agricultural land, which, if used productively, must now be put back to the original forested condition.
6. The ineffectiveness of public aid alone to make private forestry feasible, or in many cases, even to keep forest lands in private ownership.
7. The financial inability of most of the States and local units of government to take over the forest management job where private ownership has failed.
8. The apparent barriers of tradition and failure to appreciate public forest-land values, which to some degree hold back effective private forestry even where genuine financial opportunity and ability exist.

The Federal Government has two primary methods through which it can participate in the national forestry enterprise. The first method is one of systematic aid and encouragement to the States and private owners. A primary purpose of such aid in every form is to make it possible for others to own and manage forest lands, and thereby make it unnecessary for the Federal Government to do so. The established forms of Federal aid and assistance, of which this report recommends the continuation and expansion, include:

1. Direct grants of money, as for fire, insect and disease control, extension, and planting stock.
2. Returns of money to the local government, on account of Federal land ownership, such as the 25 percent of national-forest receipts.
3. Expenditure on account of land ownership for such projects as forest highways, which are integral parts of local road systems, and would otherwise be constructed by local government.
4. Carrying on of research programs, the results of which are available to all.
5. Management of Federal lands without cost to local governments, as the national forests and parks.

The second method of participating in the national forestry enterprise is by direct Federal management of Federally owned or controlled forest lands, when this proves necessary to care for the values at stake. This report recommends national expansion in this direction, leaving to private ownership the forest lands on which there is a real chance for profitable business enterprise, and to the States the amount that their financial ability will enable them to own and manage.

Many Federal agencies have a part in carrying out the forestry program of the Federal Government. The following proposed program covers specifically the work of each of these agencies which together make up the complete Federal program. The program contemplates a period of 20 years of constructive forestry effort. It contemplates the intensification and expansion of resource management. While the major program covers a period of 20 years, some of the more essential betterment measures, involving immediate protection of existing resource values, are scheduled for shorter periods.

BUREAU OF FISHERIES (DEPARTMENT OF COMMERCE)

Fish constitute an important forest resource. Research is essential in solving the many problems of fishery management on forest areas, involving (1) surveys of forested areas to determine water resources, fish populations, and the normal demand made by fishermen upon the natural supply of fish; (2) a determination of the need for additional production and a check on the method of increasing yields, and (3) studies of ecological requirements of fish and improvements in hatchery technique. The estimated cost of fishery investigative work is $25,000 per year, for the first 5-year period.

An adequate program of fishery management on Federal lands, it is estimated, would require $75,000 per year for fish cultural operations for the first 5 years. It is estimated that $150,000 will be needed each year for fish cultural operations and investigations in connection therewith, for a second 5-year period, and that $75,000 will be needed each year thereafter.

Appropriation of additional funds is needed to carry out these proposed investigative and management measures. Legislation already formulated in a bill (S. 263, 72d Cong., 1st sess.) to promote the conservation of wild life, fish, and game; and a bill (S. 5813, 71st Cong., 2d sess.) to provide for the consideration of wild-life conservation with the construction of public works or improvement projects should be enacted.

THE NATIONAL PARK SERVICE (DEPARTMENT OF THE INTERIOR)

Adequate protection of the forest lands within the national parks and monuments, under the control of the National Park Service, is needed to prevent destruction of great scenic, recreation, and watershed values, and to safeguard adjoining forest areas. This will necessitate: (1) completion of an adequate system of fire protection, and (2) adequate protection of park forests from attacks of insects and disease.

The following estimates of needed expenditures cover only forest-protection measures for park forests. The annual expenditures for fire protection for the period 1927–31 averaged $95,324. It is estimated that $482,100 is required in the next 5 years of capital expenditures for additional permanent structures and other improvements needed for fire protection; $63,200 is needed annually for fire prevention services and maintenance. These requirements will necessitate an annual expenditure for the next 5 years of $159,620, with a continuing annual expenditure after that period of approximately $63,200 for current expenses and a capital expenditure allowance of $10,000 for maintenance and replacements.

Greater disease-control effort than at present is needed; the $30,000 present (1933) allotment should be increased to $100,000 at once, and should continue in that amount.

Adequate insect control would involve increases from the present allotment of $50,000 to $75,000, which after 5 years might need to be increased to $150,000 annually.

INDIAN SERVICE (DEPARTMENT OF THE INTERIOR)

The program for adequate administration of Indian reservation forest lands contemplates (1) completion of an adequate system of fire protection, including needed capital expenditures for improvements: (2) better protection of forests from insects and disease; (3) completion of an adequate system of roads and trails for protection, administration, and management of Indian forest lands; and (4) increased funds for a larger personnel, increased supervision, and a more intensive management of all forest work in the Indian Service.

The legislative program for the Indian reservation forest lands should provide (1) for discontinuing the present practice of allotting forest and range lands to individual Indians: (2) for the creation by law of Indian forests on the several reservations having large areas of tribal land; and (3) for increased appropriations for all forestry work.

Estimated annual expenditures for the first 5 years of this program, covering administration and management of Indian forests, are given in table 4.

Table 4.—*Estimated expenditures in a 5-year program on Indian reservation forests*

	Current expenditures	Capital investment	Total expenditures
Fire protection	$250, 000	$200, 000	$450, 000
Insects and disease	20, 000		20, 000
Forest roads and trails	125, 000	350, 000	475, 000
Administration (including grazing)	300, 000	23, 000	323, 000
Total	695, 000	573, 000	1, 268, 000

BIOLOGICAL SURVEY (DEPARTMENT OF AGRICULTURE)

In order to carry out adequately the needed experiments and investigations for determining the life histories and habits of forest animals, birds, and wild life, as authorized by the McSweeney-McNary Act, the current appropriation of $20,000 for the fiscal year 1933, should be increased up to the amounts authorized in the act, reaching a maximum of $150,000 in 1938. Thereafter, funds should be provided as needed.

Range-destroying rodents which live on herbaceous and shrubby vegetation are causing excessive losses in range-forage values over large areas within the national forests. It is estimated that there are about 8 million acres now infested with these pests, requiring application of control measures. Other rodents cause severe damage to tree growth. Porcupines are preventing the establishment of new forest growth over large areas, particularly in the ponderosa pine type. The Biological Survey estimates that, in order to obtain adequate rodent control in the national forests, annual expenditures should be increased from the present amount of $50,000 to $116,000 for about 5 years, that for a second 5-year period annual expenditures of approximately $92,000 will be needed, for the next 10 years about $62,000 will be needed annually for follow-up work, to prevent reinfestations and to maintain controlled conditions. The estimate for porcupine work included in the above total is based on present known conditions in the Rocky Mountain region. Further investigations may reveal additional areas needing treatment.

The predatory-animal control work of the Biological Survey has an important bearing on use of the forage resources of the national forests. It is not possible to segregate expenditures on the national forests since the control work is carried on also on other lands.

BUREAU OF PLANT INDUSTRY (DEPARTMENT OF AGRICULTURE)

AID IN DISEASE CONTROL

The control of epidemics of introduced forest diseases through cooperative measures is a necessary function of the Federal Government. The cooperative control work against the white pine blister rust should be increased promptly in order to prevent excessive losses in valuable stands of white pines, which include three important timber species.

It is proposed that the general appropriation act be changed to authorize the Division of Blister Rust Control of the Bureau of Plant Industry to cooperate also in the control of other diseases, bridging the gap between research and application. This would involve service particularly in connection with the elimination of decayed or disease-susceptible trees in cutting operations; and with nursery sanitation and the selection of healthy sites and species combinations for plantations. Much of the recommended expansion of duties can be cared for by utilizing the present forces of the Division with relatively little increase in personnel.

It is estimated that in order to handle this work adequately the present annual expenditure of $344,500 will require increase at once to $554,000 and progressively to $719,000 by 1939. After 1939 the expenditures for maintaining the blister rust portion of this protection should materially decrease if the indicated program is carried out.

RESEARCH IN DISEASES OF FORESTS AND FOREST PRODUCTS

The need for information on control of forest tree diseases and diseases of forest products requires continued forest pathology investigations. The current (1933) appropriation of $120,000 is insufficient for adequate research upon the great number and variety of problems with which the various owners of forest land are faced. Appropriations are needed up to the $250,000 authorized by the McSweeney-McNary Act.

For investigation on newly introduced diseases in forests, which are not covered by the act, the present funds of approximately $24,000 need an early increase if the Dutch elm disease and the new beech bark disease are to be adequately attacked. The seriousness of the beech disease is only now being recognized, and the possibilities for control cannot be determined until further study of the situation is made.

DISEASE CONTROL ON FEDERAL LANDS

The Bureau of Plant Industry cooperates with other Federal agencies by advice in disease control technique on Federal lands. The allotment of the Bureau of Plant Industry of $40,500 for advice in control work on the national forests should be increased to $160,000 by 1935, and should progressively increase to $189,000 by 1939. The allotment of $15,000 for disease control advice on the national parks should be increased to $20,000 by 1935 and should increase progressively to $25,000 by 1939. An increase in appropriations of $6,000 for the Bureau of Plant Industry should be made for disease control work on the Indian reservations. This estimate is made for a 5-year period only. Due to numerous unknown factors it is impracticable to estimate subsequent needs. If the indicated program is carried out it is probable that expenditures after the 5-year period will decrease.

BUREAU OF ENTOMOLOGY (DEPARTMENT OF AGRICULTURE)

There is need for a great deal of additional study of destructive forest insects as a basis for satisfactory prevention and control methods. Insects attacks cause an annual loss in timber values of millions of dollars. Appropriations should be increased up to the amounts authorized by the McSweeney-McNary Act which provides for a maximum of $350,000 annually by 1938. Thereafter necessary funds should be made available as provided for under the provisions of the Act.

BUREAU OF PLANT QUARANTINE (DEPARTMENT OF AGRICULTURE)

The Federal Government maintains protection against the introduction of forest diseases and injurious forest insects from foreign countries by the quarantine work supervised by the Bureau of Plant Quarantine. Danger of the spread of destructive diseases or insect pests is reduced by inspection and certification of shipments of plant stock between States. This Bureau also supervises the actual control work in the supression of the gypsy moth epidemic in the Northeast for which $400,000 was appropriated in 1933. All of these operations should be continued and adequately financed as a proper governmental function. It is estimated that adequate control of the gypsy moth, with small amounts for control of the brown tail, satin, and European pine shoot moths would cost in the neighborhood of $700,000 annually.

WEATHER BUREAU (DEPARTMENT OF AGRICULTURE)

In order to make adequate investigations of the relationship of weather conditions to forest fires, as may be necessary to make weather forecasts, the funds authorized for such research in section 6 of the McSweeney-McNary Act should be made available, increasing from present (1933) allotments of $4,650 up to the full authorization of $50,000 annually in 1938. Thereafter, funds should be provided as needed.

It is contemplated that the Weather Bureau will continue its service of disseminating fire-weather information to public and private fire-control agencies during the periods of serious fire hazard. The present (1933) allotment is $37,690 for this purpose. It is estimated that this amount should be increased to about $45,000 by 1935.

FOREST SERVICE (DEPARTMENT OF AGRICULTURE)

COOPERATIVE FINANCIAL AID TO STATES AND PRIVATE OWNERS

The Federal Government through the agency of the Forest Service furnishes cooperative financial aid to States and private owners for specified purposes, which at the present time are limited to (1) fire protection, (2) distribution of planting stock, and (3) forest extension. Such Federal forestry aid makes up less than one percent of all Federal aid funds.

FIRE PROTECTION

Funds for fire protection make up the bulk of Federal aid. Some degree of organized protection from fire is now obtained on only 54 percent of the total State and privately owned forest area in the United States. The cost of this cooperative fire protection was $5,943,000 in 1932, of which the Federal Government put up $1,573,000 (27 percent), the States $3,276,000 (55 percent), and private funds amounted to $1,094,000 (18 percent).

The present Federal authorization as carried in the Clarke-McNary Act amounts to $2,500,000 on the basis of a former estimate that $10,000,000 would be the total amount necessary to protect State and private forest land. Estimates indicate that the cost of adequate fire protection may ultimately amount to approximately $20,000,000. On the 75-25 percent basis for meeting control expenditures as explained in the section entitled, "Federal Financial and Other Direct Aid to the States," the present limitation on Federal authorizations contained in the Clarke-McNary law should be increased to $5,000,000. Appropriations should be immediately increased to 50 percent of the total current expenditures, provided that no State should in any year receive more than 25 percent of its total needs. On this basis $2,680,500 could be spent immediately to good advantage on this project. This represents a substantial increase over the 1933 appropriation, which was $1,611,580. During the following 10 years Federal aid in forest-fire protection should be increased each year until it reaches $3,703,500 in 1944; thereafter additional funds will be needed as additional areas are placed under protection and for adequate protection on all areas needing protection.

FOREST PLANTING

It is estimated that approximately 25 million acres in the United States, of which 5,755,000 acres are listed as private timber lands, should be planted to forest trees during the next 20 years. It is desirable to continue the present method of Federal cooperation whereby the Government contributes to the costs of establishing and operating State forest nurseries.

Legislation is needed to increase the expenditures authorized by section 4 of the Clarke-McNary Act from $100,000 to $350,000 and to broaden the scope of the act so that its provisions will benefit all landowners. Expenditures should increase progressively from $150,000 in 1935 to approximately $350,000.

A greatly enlarged forest-planting program such as that proposed for public and private agencies requires aid in securing sufficient seed supplies and all agencies should be protected against inferior seed or seed unsuited to the locality where it is planted. This can best be attained if the Federal Government as a form of public aid will supply of a seed testing and certification service, the cost of which is estimated at $50,000 per year. Legislative authority to conduct the work and appropriation of funds is needed.

FOREST INSECTS

In insect control work the Federal Government now assists the States and private timberland owners by conducting control work where serious insect epidemics threaten. Legislation authorizing Federal cooperation to the extent of $250,000 annually for cooperative survey and local insect-control work on State and private lands is needed. Appropriations should begin at $50,000, increasing in a 5-year period to $250,000 annually, or as rapidly as private and State cooperative funds are made available. Further increases may later be found necessary for adequate control.

FOREST EXTENSION

Advice on the ground is one of the most effective forms of aid that the Government can give to private owners. The work can probably best be handled through a special advisory service similar to that whereby the Federal Government and the States cooperate in maintaining extension foresters in farm forestry.

At present the Federal cooperative forest-extension activities are limited by the Clarke-McNary Act to farmers. The Federal cooperative effort for the most part fails to reach a large class of other private owners who actually own 270 million acres of forest land. Needed expansion of this work will necessitate an amendment to the Clarke-McNary law providing authorization for increased expenditures for the purpose and broadening the scope of the act to benefit all forest landowners. It is estimated that $625,000 will be needed for all Federal extension activities. Of this $225,000 should be available the direct forest-extension work by the Forest Service; $150,000 additional should be provided the Forest Service to match State funds for work with timber landowners other than farmers; and a maximum of $250,000 should be provided ($100,000 at present) to be used annually to match expenditures by the States for farm forest extension through the Extension Service (Clarke-McNary law, sec. 5). Total funds for these three purposes should be increased progressively from $200,000 the first year to $625,000 the tenth year, and $625,000 annually thereafter.

FOREST RESEARCH

Earlier sections of this report have recommended an enlarged Federal forest-research program.

Forest research has been hopelessly inadequate for the forestry effort of the past and work on the present scale would be even more so for the greatly enlarged effort recommended by this report.

The Federal Government's responsibility for adequate forest-research covers not only the problems with which the Federal Government is confronted in the management of Federal forest lands, but also forestry problems which are of a national or regional character. Technical knowledge is needed on all phases of forestry to guide the work efficiently and prevent serious mistakes.

Research work of the Forest Service has not kept pace with the authority granted by the McSweeney-McNary Act, due to lack of funds. Adequate financing is needed to carry out the program outlined to 1938. It is now apparent, however, that the maximum limitations set up in the McSweeney-McNary Act represent no more than a satisfactory beginning if the need for research is met on an adequate basis. Certain forest-research work that has been authorized has not yet been started. Practically nothing has been done toward setting up an adequate forest experiment station in the central Rocky Mountain region, nor has any attempt been made toward establishing the stations authorized for Alaska, Hawaii, or the West Indies. Expansion and speeding up of certain lines of research is of immediate importance and amply justifiable as an emergency measure.

EROSION AND STREAMFLOW INVESTIGATIONS

Of foremost importance at this time is the need for studies of the relationship between forest cover and erosion and streamflow conditions as a basis for erosion control and streamflow regulation.

A bill similar to that introduced in the Seventy-second Congress (H.R. 4608) which provided for an additional section in the McSweeney-McNary Forest Research Act to cover erosion-streamflow investigations on forest, range, and other wild lands should be enacted. The legislation should provide an authorization for annual appropriations of not more than $500,000 until 1938, and additional amounts thereafter as needed.

FOREST SURVEY

Since work on the forest survey, a Nation-wide study, was begun in 1930, it has become apparent that its maximum value cannot be attained unless the job is completed in a relatively short period of time.

The results of the forest survey are urgently needed for such things as land-use planning and in fact are already being used for this purpose. The importance of accelerating the work is being strongly urged by States, counties, and other agencies. They recognize the pressing need for such an inventory and analysis as the basis for the formulation of public policies and programs.

The present authorization of $250,000 should be increased to $500,000. Provision should also be made for keeping the data current indefinitely, at a probable cost of $200,000 annually.

LAND CLASSIFICATION

The general land-use situation is one of the most critical of the national internal problems. Prompt and intelligent action based upon a clear understanding of the uses for which different classes of land are best suited is essential in determining the National land-use policy. Classification of our existing and potential forest land according to the use to which it is best adapted is an important part of the whole vexing problem. The funds needed for the forestry part of such a program should begin at $75,000, the first year, and increase progressively to $250,000 the fourth year. It may later be found that as much as $400,000 will be needed.

Legislation is needed to authorize forest land classification work and to provide funds. Provision may be made either in connection with general classification legislation or as an amendment to the McSweeney-McNary Act.

FOREST ECONOMICS

Forest economics investigations should strike directly at the heart of the baffling economic difficulties which confront the intelligent management of both public and privately owned forest land. They should help to furnish the factual foundation for making forest land use in the broad sense of the term take its proper place in our entire economic and social structure.

To carry out such a program the appropriation for this work for the fiscal year 1933 of $70,240 should be increased progressively to $250,000 by 1938. Appropriations thereafter should be increased progressively to $400,000 by 1944.

FOREST PRODUCTS

As one means of assuring full land use, forest products must be kept in a position to compete on equal terms with other commodities, and research is necessary to this end. Forest-products research would also be effective in alleviating some of the emergency conditions growing out of the depression such as the need for much cheaper houses. Any improvement would be reflected in increased demands for lumber and relief of acute unemployment in communities and regions dependent on the forest industries.

To meet the needs of this program, appropriations for forest products investigations of $613,640 for the fiscal year 1933 should be increased progressively to $1,050,000 by 1938, and to $1,650,000 by 1944.

EXPENDITURES NEEDED FOR ALL FOREST SERVICE RESEARCH

To cover the classes of forest research indicated and in addition research in forest management for the growing of forest crops and their protection against fire, research in the management and utilization of forest ranges, and studies of forest taxation and insurance progressive increases from $1,666,750 for the fiscal year 1933 to $3,885,000 by 1938 and to $5,235,000 by 1944 will be needed.

Since the results of Forest Service research on the broad regional and national forest problems, as well as on the local problems of federally owned and managed lands are of direct benefit to the States and private owners, research constitutes an important form of Federal aid.

NATIONAL-FOREST ACQUISITION

AREA PROPOSED

The total area recommended for acquisition and addition to the national forests (exclusive of the public domain) is about 134 million acres. This is approximately 60 percent of the forest acquisition program for all public agencies and contemplates the purchase or acquisition by other means of 107 million acres east of the plains and 27 million acres in the West over a period of 20 years. Acquisition is recommended at an average annual rate of 5,350,000 acres in the

East and 1,350,000 acres in the West. The program includes the purchase within the first 10 years of about 90 billion feet of stumpage in the West primarily as a means to maintain the existing forest capital.

In addition about 22 million acres of forest land now in the public domain are recommended for immediate addition to the national forests.

LEGISLATION NEEDED

1. An authorization act covering a period of not less than 10 years, with an annual authorization of $30,000,000 made available until expended.

Stumpage purchases it is estimated would require $10,000,000 of the above amount. It is suggested that a plan might be worked out for stumpage purchases whereby the Federal Government would purchase the stumpage but would defer payment for a period not to exceed 20 years, until the stumpage is cut. Such a plan would ease the burden on the Treasury by providing for payment coincident with income from stumpage, would relieve the holders of the stumpage in the interim from excessive carrying charges, and would make possible the speeding up of the land-purchase program.

2. An act to permit exchanges of private lands within 6 miles of the exterior boundary of any existing national forest.

3. Legislation providing for the addition to the national forests of about 22,179,000 acres of public domain.

COSTS OF ACQUISITION

Some part of the proposed area will no doubt be acquired by donation and part (mostly in the West) will probably be acquired by exchange. Allowing for this, the cost of acquisition for the entire eastern area is estimated at $3.23 per acre, or less than two thirds of the average price paid to date. In the West the cost is estimated at $1.60 per acre exclusive of additions from the public domain which do not involve any costs for land.

THE ADMINISTRATION AND MANAGEMENT OF THE EXISTING NATIONAL FORESTS

The section entitled "Ownership Responsibilities, Costs, and Returns" deals specifically with additional measures needed adequately to administer and manage existing national forests. This program contemplates the intensification and expansion of resource management. It provides for speeding up capital expenditures for physical improvements and cultural operations in order to add value to the resources and to increase returns and services.

In estimating the average annual expenditures for a 20-year period, a lump-sum allowance has been made for replacement and maintenance of roads and trails and structural improvements, after the completion of the programed construction period. In the case of betterment operations for which increases are programed for less than the 20-year period, such as control of the white-pine blister-rust disease, it is assumed that the amounts that are now being expended for these various operations will be sufficient for necessary continuing work.

PROTECTION AGAINST FIRE

Protection against fire is particularly critical on about 30 million acres in three important forest regions. Major conflagrations still occur under adverse climatic conditions, are suppressed at great cost, and with loss of public property and life. The average annual area burned over should be reduced at the earliest possible date.

Completion of an adequate fire-protection system, including the construction of fire roads and trails and other fire improvements, involves an estimated annual expenditure of $3,700,000 for fire roads and trails programed for 10 years and $780,000 for other fire improvements programed for 5 years. It is estimated that a progressive annual increase in expenditure will be needed, beginning at $80,000 and continuing up to $625,000 the tenth year, for increased man power in inaccessible areas to replace road and trail workers who were available for protection during construction periods. This increased expenditure for man power should continue after the tenth year at the rate of $625,000.

PROTECTION AGAINST DISEASE

Of first importance in the program for protection against disease is the control of the white-pine blister-rust, which attacks all of the five needle pines.

It is estimated that an increased annual expenditure of $1,700,000 will be required for about 5 years for adequate control work on 3 million acres in the West where the highest commercial values in white and sugar pine are threatened.

The bulk of this project is concentrated in the first 5-year period beginning with 1935, because delay will jeopardize existing timber values.

PROTECTION AGAINST INSECTS

Work now conducted must be permanently expanded to obtain adequate current control of insect damage, to meet emergencies, and prevent severe losses caused by epidemic insect attacks. This involves an increase of $100,000 over present annual expenditures of about $100,000.

TIMBER MANAGEMENT

Probable increases in the sale of timber on the national forests during the next 20 years will, it is estimated, result in a material increase of work, and will necessitate an increase in average annual expenditures of $215,000.

At the present time stand-betterment work, which is important in placing the forest property in condition to yield maximum timber supplies, is done only on going timber sales. There is no direct expenditure for it. It is proposed to extend this work to areas outside of the immediate timber-sale operations throughout the 20-year period. This would require an annual expenditure of at least $1,000,000.

The total planting program for the existing national forests is 2,100,000 acres, scheduled for the 20-year period. This will require an increase of $840,000 over present annual expenditures.

GRAZING MANAGEMENT

Intensification of grazing management is needed to provide adequate protection of forage and watershed values, and to obtain maximum returns from proper grazing use of the forage resource. The work will be a continuing management job, and the estimated needed increase over present annual expenditure is $50,000. It may be found that additional increases will be needed in the future.

Additional improvements, such as fences, watering places, counting corrals, etc., needed to facilitate and improve the administration and use of the forage resources, are a necessity in developing and protecting forage and water-shed values. For this reason the work and expenditures should be concentrated in the first 10-year period. The increased annual expenditure needed is estimated at $180,000.

About 100,000 acres of valuable range lands are estimated to be badly infested with poisonous plants, which limit the use of such areas and cause excessive losses of domestic livestock. There is, of course, urgent need that this menace to livestock be removed at the earliest opportunity, and the eradication work is therefore programmed for the first 10-year period. Thereafter current follow-up will be needed to protect the investment and maintain the value of the improved ranges. It is estimated that increased annual expenditures for this project should begin at about $50,000 and increase progressively in the 10 years to about $500,000.

Control of range-destroying rodents is also an important factor in restoring the productivity of large areas of rodent-infested range lands on the western national forests. The work, which is carried on in cooperation with the Biological Survey, should be prosecuted aggressively, to prevent reinfestation of areas already treated and to provide adequate control on all areas.

The bulk of the work is programmed for the first 10-year period, and for this purpose increased annual expenditures are needed. Increases should begin at about $50,000 and advance progressively to $68,000. The work is important not only to the Federal Government but to users of national-forest range.

Serious erosion is resulting from the depletion of vegetative cover on some 810,000 acres of national-forest range land and immediate control is needed. Artificial reseeding will hasten the restoration of vegetative cover and aid in watershed protection. Reseeding of this area is planned for the next 20 years, at an estimated annual expenditure of $125,000.

RECREATION

It is estimated that the rapid increase in the recreational use of the national forests involves an increased annual expenditure of $100,000 adequately to handle the supervision of this activity.

Adequate sanitation and other facilities for use of recreational areas are essential to public health and to other benefits to be derived from recreational use of the forest. Construction of needed recreational improvements is regarded as sufficiently urgent to be programmed for the first 5-year period, at an estimated increase in annual expenditures of $450,000.

The expansion and intensification of wild-life management work needed to provide for the best use and development of the wild-life resources of the national forests will necessarily be of a continuing character. The estimated needed increase in annual expenditures for this purpose is $153,000.

Legislation needed to establish and protect the recreational resources of the national forests includes:

(1) Legal recognition of recreation as a national forest resource to be developed.

(2) Authorization for the development and regulation of campsite areas.

(3) Amendment to present legislation to allow granting of term permits for areas up to 80 acres. The present limitation is 5 acres.

All of the legislation concerning recreation needs is embodied in a bill (H.R. 58) introduced in the House of Representatives March 9, 1933, and now pending before the Seventy-third Congress.

LANDS

Expansion of the present organization is needed to handle adequately the proposed program for acquisition of forest land, and for management of commercial national forest land uses. The work will be continuing in character. The needed increases over present annual expenditures is estimated at $64,000.

MISCELLANEOUS IMPROVEMENTS

Construction of additional forest-development roads and trails, such parts of the forest highway program as are chargeable to the development of the national forests, telephone lines, structures, pastures, and other improvements are all needed for adequate national forest administration and management.

Road and trail construction and forest highways chargeable to the national forests are programmed for 10 years, at an estimated increased annual expenditure of $4,840,000. Other improvements are programmed for 5 years, and are estimated to require an increased annual expenditure of $300,000.

ESTIMATED AVERAGE ANNUAL EXPENDITURES NEEDED

Expenditures for the fiscal year 1933 will amount to approximately $7,384,275 for the current management of the national-forest properties, and $12,036,689 for capital investments. The program of administration and management for existing national forests proposed in the preceding paragraphs on a 20-year basis will require estimated average annual expenditures by 5-year periods as shown in table 5.

TABLE 5.—*Estimated average annual expenditures for administration and management*

Period	Current maintenance	Capital expenditures [1]	Total cost
First 5-year period [2]	$8,272,000	$17,250.000	$25,522,000
Second 5-year period	8,581,000	14,280,000	22,861,000
Third 5-year period	8,691,000	[2] 4,465,000	13,156,000
Fourth 5-year period	8,691,000	4,465,000	13,156,000

[1] Capital investment includes $3,300,000 forest highway considered as a direct charge to the national forests.

[2] The decrease in capital expenditures after the second 5-year period is due to the fact that most of the large construction and betterment projects are scheduled during the first 10-year period.

Estimated expenditures needed for the first 10-year period of the program are shown in table 6. Many of the major increased expenditures for capital investments, as far as can now be foreseen, should be completed during this period, some as early as the fifth year. A few of the additional expenditures increase progressively during the first 5-or 10-year period. Therefore the table is arranged to show the estimated expenditures for each year of the first 5-year period, and the estimated average annual expenditures for the second 5-year period, segregated as to current and capital expenditures. The estimated division of fiscal year 1933 appropriations by current and capital expenditures for administration and management are carried through the 10-year period as lump sums, since it is assumed that these appropriations will be continuing. Needed additional expenditures are segregated by the activities to which they contribute.

TABLE 6.—*Estimated expenditures for the administration and management of existing national forests*

[10-year period]

Activity	First 5-year period										Second 5-year period	
	First year		Second year		Third year		Fourth year		Fifth year		(Average annual)	
	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital
Present expenditures (1933) [1]	$7, 384, 275	$3, 131, 689	$7, 384, 275	$3, 131, 689	$7, 384, 275	$3, 131, 689	$7, 384 275	$3, 131, 689	$7, 384, 275	$3, 131, 689	$7, 384, 275	$3, 131, 689
Increases needed:												
Protection:												
Fire roads and trails		3, 700, 000		3, 700, 000		3, 700, 000		3, 700, 000		3, 700, 000		3, 700, 000
Improvements		780, 000		780, 000		780, 000		780, 000		780, 000		
Man power	80, 000		125, 000		200, 000		275, 000		350, 000		[2] 515, 000	
Insects	100, 000		100, 000		100, 000		100, 000		100, 000		100, 000	
Disease		1, 700, 000		1, 700, 000		1, 700, 000		1, 700, 000		1, 700, 000		
Timber management expansion:												
Current work	215, 000		215, 000		215, 000		215, 000		215, 000		215, 000	
Stand betterment		1, 000, 000		1, 000, 000		1, 000, 000		1, 000, 000		1, 000, 000		1, 000, 000
Planting		840, 000		840, 000		840, 000		840, 000		840, 000		840, 000
Grazing management:												
Intensification management	50, 000		50, 000		50, 000		50, 000		50, 000		50, 000	
Range improvements		180, 000		180, 000		180, 000		180, 000		180, 000		180, 000
Poisonous plant eradication		50, 000		100, 000		150, 000		200, 000		250, 000		[3] 400, 000
Rodent control		50, 000		52, 000		54, 000		56, 000		58, 000		[4] 64, 000
Artificial range: Reseeding		125, 000		125, 000		125, 000		125, 000		125, 000		125, 000
Recreation:												
Increase current work	100, 000		100, 000		100, 000		100, 000		100, 000		100, 000	
Improvements		450, 000		450, 000		450, 000		450, 000		450, 000		
Wild life	153, 000		153, 000		153, 000		153, 000		153, 000		153, 000	
Lands: Increase current work	64, 000		64, 000		64, 000		64, 000		64, 000		64, 000	
Administrative improvements:												
Forest development roads		1, 500, 000		1, 500, 000		1, 500, 000		1, 500, 000		1, 500, 000		1, 500, 000
Forest development trails		40, 000		40, 000		40, 000		40, 000		40, 000		40, 000
Miscellaneous improvements		300, 000		300, 000		300, 000		300, 000		300, 000		
Forest highways [5]		3, 300, 000		3, 300, 000		3, 300, 000		3, 300, 000		3, 300, 000		3, 300, 000
Total	8, 146, 275	17, 146, 689	8, 191, 275	17, 198, 689	8, 266, 275	17, 250, 689	8, 341, 275	17, 302, 689	8, 416, 275	17, 354, 689	8, 581, 275	14, 280, 689

[1] Capital expenditures do not include $5,905,000 for forest highways and $3,000,000 for forest development, roads and trails.

[2] Progressive increases from $350,000 to $625,000 during the second 5 years.

[3] Progressive increases from $250,000 to $500,000 during the second 5 years.

[4] Progressive increases from $58,000 to $68,000 during the second 5 years.

[5] Considered as a direct charge to national forests. (Annual allowance represents the part of total that may be appropriated.)

NOTE.—$1,000,000 estimated annual expense for construction of check dams and bank control works excluded from table pending further investigations and more detailed cost estimates.

ADMINISTRATION AND MANAGEMENT OF AREAS PROPOSED FOR EXTENSION OF THE NATIONAL FOREST SYSTEM

This program assumes that administration and management of acquired lands will begin as soon as the Federal Government assumes ownership. Table 7 shows the estimated average annual expenditures for administration and management of the 107,100,000 acres proposed for acquisition east of the plains, and of the 27,100,000 acres in the West, and areas recommended for addition to the national forests from the public domain. The estimated annual expenditure for the above addition from the public domain is $1,038,000, and this figure is included in table 7, which is arranged in four 5-year periods covering the total 20-year program.

A progressive percentage increase is assumed for capital expenditures, beginning at 1 percent in the East for the first year and increasing to 8 percent for the fifth and sixth years. Thereafter the capital expenditures are figured at 10 percent until the total of annual expenditures reach 100 percent in the thirteenth year. Thereafter, beginning with the sixteenth year an annual allowance is made for replacement, maintenance, and emergencies.

In the West it is assumed that 5 percent of the total capital expenditures will be made the first year, will increase to 25 percent the fifth year, and will be about 10, 10, and 5 percent, respectively, the sixth, seventh, and eighth years. Beginning with the tenth year, an annual allowance of $500,000 is made for replacement, maintenance, and emergencies.

TABLE 7.—*Estimated average annual expenditures for administration and management of proposed additions* [1] *to national-forest system*

Region	First 5-year period		Second 5-year period		Third 5-year period		Fourth 5-year period	
	Current expenditures [2]	Capital expenditures [3]	Current expenditures	Capital expenditures	Current expenditures	Capital expenditures	Current expenditures	Capital expenditures
East	$2, 506, 140	$9, 424, 800	$6, 683, 040	$20, 563, 200	$9, 253, 440	$12, 852, 000	$10, 752, 840	$2, 000, 000
West	1, 444, 500	4, 065, 000	2, 122, 000	1, 355, 000	2, 799, 500	500, 000	3, 477, 000	500, 000
Total	3, 950, 640	13, 489, 800	8, 805, 040	21, 918, 200	12, 052, 940	13, 352, 000	14, 229, 840	2, 500, 000

[1] Total acquisition program for East, 107,100,000 acres, or 5,355,000 acres per year; total acquisition program for West, 27,100,000, or 1,355,000 acres per year and about 22,179,000 acres of additions from public domain.

[2] Protection for East figured at 5 cents per acre and for double area actually acquired for first 10 years. For West protection figured at 5 cents per acre. Administration for East figured at 5.6 cents per acre and for West at 5 cents per acre for all areas exclusive of public domain.

[3] Total capital investment for eastern acquisition computed at $2 per acre and for West at $1 per acre.

Under the proposed program current expenditures will progressively increase as the acquisition program proceeds. Capital expenditures, however, increase rapidly during the first 10 years, and then decline rapidly to an allowance for maintenance and replacement. Table 8 is arranged to show the estimated annual expenditure for each year of the first 5-year period and the average annual expenditure for the second 5-year period. The expenditures are divided by areas east of the Plains and the West.

Current expenditures are separated into those for (1) protection, and (2) administration and management. Capital expenditures cannot be satisfactorily divided and are therefore included as a lump sum.

This table also includes a summary of expenditures which brings together in total amounts for a 10-year period the estimates for administration and management for existing national forests and the areas proposed for acquisition, including additions from the public domain.

TABLE 8.—*Estimated expenditures for administration and management of area proposed for acquisition and extension of the National Forest System* [1]

[First 10-year period]

Administration and management	First year, 1935		Second year, 1936		Third year, 1937		Fourth year, 1938		Fifth year, 1939		Second 5-year period, 1940–44	
	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital	Current	Capital
East of Plains:												
Capital expenditures		$2,142,000		$6,426,000		$8,568,000		$12,852,000		$17,136,000		$20,563,200
Protection [2]	$535,500		$1,071,000		$1,606,500		$2,142,000		$2,677,500		$4,284,000	
Administration [3]	299,880		599,760		899,640		1,199,520		1,499,400		2,399,040	
Total for East	835,380	2,142,000	1,670,760	6,426,000	2,506,140	8,568,000	3,341,520	12,852,000	4,176,900	17,136,000	6,683,040	20,563,200
West of Plains:												
Capital expenditures		1,355,000		2,710,000		4,065,000		5,420,000		6,775,000		1,355,000
Protection [4]	67,750		135,500		203,250		271,000		338,750		542,000	
Administration [4]	67,750		135,500		203,250		271,000		338,750		542,000	
Total for West	135,500	1,355,000	271,000	2,710,000	406,500	4,065,000	542,000	5,420,000	677,500	6,775,000	1,084,000	1,355,000
Total, East and West	970,880	3,497,000	1,941,760	9,136,000	2,912,640	12,633,000	3,883,520	18,272,000	4,854,400	23,911,000	7,767,040	21,918,200
Public-domain additions to national forests, administration and management	1,038,000		1,038,000		1,038,000		1,038,000		1,038,000		1,038,000	
United States, total	2,008,880	3,497,000	2,979,760	9,136,000	3,950,640	12,633,000	4,921,520	18,272,000	5,892,400	23,911,000	8,805,040	21,918,200

[1] Total purchase program for East, 107,100,000 acres, or 5,355,000 acres each year. Total purchase program for West, 27,100,000 acres, or 1,355,000 acres each year. Additions from public domain, 22,179,000 acres.

[2] Protect double the area acquired at 5 cents per acre for 10 years or until total area is under protection.

[3] 5.6 cents per acre.

[4] 5 cents per acre.

Summary of estimated expenditures for administration and management of the national forests

[First 10-year period]

Administration and management	First year, 1935		Second year, 1936		Third year, 1937	
	Current	Capital	Current	Capital	Current	Capital
Existing national forests	$8, 146, 275	$17, 146, 689	$8, 191, 275	$17, 198, 689	$8, 266, 275	$17, 250, 689
Additions to national forests	2, 008, 880	3, 497, 000	2, 979, 760	9, 136, 000	3, 950, 640	12, 633, 000
Grand total	10, 155, 155	20, 643, 689	11, 171, 035	26, 334, 689	12, 216, 915	29, 883, 689

Administration and management	Fourth year, 1938		Fifth year, 1939		Second 5-year period, 1940–44	
	Current	Capital	Current	Capital	Current	Capital
Existing national forests	$8, 341, 275	$17, 302, 689	$8, 416, 275	$17, 354, 689	$8, 581, 275	$14, 280, 689
Additions to national forests	4, 921, 520	18, 272, 000	5, 892, 400	23, 911, 000	8, 805, 040	21, 918, 200
Grand total	13, 262, 795	35, 574, 689	14, 308, 675	41, 265, 689	17, 386, 315	36, 199, 889

SUMMARY OF ESTIMATED FEDERAL EXPENDITURES

FIRST 10 YEARS

Table 9 contains a summary of the estimated expenditures for the first 10 years of the Federal program, arranged by agencies, and divided by the broad activities of aid, research, and administration, and management. In a few cases where protection is the major function of forest management "protection" has been used as a designation rather than "administration and management." In some cases other terms are used which will indicate the character of the activities. Under "Forest Service" a slightly more detailed breakdown of activities has been made than for other agencies, due to a wider range of forestry activities and to give a better understanding of the purpose of the expenditures.

The table is divided into two 5-year periods. Estimated annual expenditures are shown for each year of the first 5-year period, and the average anual expenditure for the second 5-year period.

TABLE 9.—*Federal forestry program summary of estimates for each year for the first 5 years and average annual estimates for second 5-year period*

[10-year period]

Agency and character of expenditure	1935, first year		1936, second year		1937, third year	
	Current	Capital	Current	Capital	Current	Capital
Department of the Interior						
Indian Service, management	$695,000	$573,000	$695,000	$573,000	$695,000	$573,000
National Park Service, protection	238,200	96,420	238,200	96,420	238,200	96,420
Department of Commerce						
Bureau of Fisheries, management and investigations	100,000	------------	100,000	------------	100,000	------------
Department of Agriculture						
Weather Bureau:						
Research	35,000	------------	40,000	------------	45,000	------------
Forest fire weather-warnings	45,000	------------	45,000	------------	45,000	------------
Plant quarantine, aid	700,000	------------	700,000	------------	700,000	------------
Plant industry:						
Aid	554,000	------------	595,000	------------	636,000	------------
Research	174,000	------------	207,000	------------	240,000	------------
Disease control on Federal land	186,000	------------	195,000	------------	203,000	------------
Extension service, aid (farm forest extension)	100,000	------------	125,000	------------	150,000	------------
Bureau of Entomology, research	245,000	------------	280,000	------------	315,000	------------
Biological Survey:						
Research	55,000	------------	85,000	------------	115,000	------------
Rodent control on national forests	116,000	------------	116,000	------------	116,000	------------
Forest Service:						
Aid:						
Fire protection	2,680,500	------------	2,958,500	------------	3,298,500	------------
Forest planting	200,000	------------	212,500	------------	225,000	------------
Insect control	50,000	------------	100,000	------------	150,000	------------
Forest extension	100,000	------------	150,000	------------	200,000	------------
Research	2,220,000	------------	2,815,000	------------	3,420,000	------------
Acquisition	------------	29,464,650	------------	29,464,650	------------	29,464,650
Management existing national forests	8,146,275	17,146,689	8,191,275	17,198,689	8,266,275	17,250,689
Management extension national forest system	2,008,880	3,497,000	2,979,760	9,136,000	3,950,640	12,633,000
Total, Forest Service	15,405,655	50,108,339	17,407,035	55,799,339	19,510,415	59,348,339
Grand total, Federal	18,648,855	50,777,759	20,828,235	56,468,759	23,108,615	60,017,759

TABLE 9.—*Federal forestry program summary of estimated expenditure for each year for the first 5 years and average annual estimates for second 5-year period*—Continued

[10-year period]

Agency and character of expenditure	1938, fourth year		1939, fifth year		Annual average for 1940–44, second 5-year period	
	Current	Capital	Current	Capital	Current	Capital
Department of the Interior						
Indian Service, management	$695,000	$573,000	$695,000	$573,000	$695,000	$65,000
National Park Service, protection	238,200	96,420	238,200	96,420	313,200	10,000
Department of Commerce						
Bureau of Fisheries, management and investigations	100,000	------------	100,000	------------	150,000	------------
Department of Agriculture						
Weather Bureau:						
Research	50,000	------------	50,000	------------	50,000	------------
Forest fire weather warnings	45,000	------------	45,000	------------	45,000	------------
Plant quarantine, aid	700,000	------------	700,000	------------	700,000	------------
Plant industry:						
Aid	677,000	------------	719,000	------------	------------	------------
Research	274,000	------------	274,000	------------	------------	------------
Disease control on Federal land	211,000	------------	220,000	------------	------------	------------
Extension service, aid (farm forest extension)	175,000	------------	200,000	------------	245,000	------------
Bureau of Entomology, research	350,000	------------	350,000	------------	350,000	------------
Biological Survey:						
Research	150,000	------------	150,000	------------	150,000	------------
Rodent control on national forests	116,000	------------	116,000	------------	92,000	------------
Forest Service:						
Aid:						
Fire protection	3,628,500	------------	3,668,500	------------	3,703,500	------------
Forest planting	237,500	------------	250,000	------------	287,500	------------
Insect control	200,000	------------	250,000	------------	250,000	------------
Forest extension	250,000	------------	300,000	------------	360,000	------------
Research	3,885,000	------------	4,250,000	------------	4,597,000	------------
Acquisition	------------	29,464,650	------------	29,464,650	------------	29,464,650
Management existing national forests	8,341,275	17,302,689	8,416,275	17,354,689	8,581,275	14,280,689
Management extension national forest system	4,921,520	18,272,000	5,892,400	23,911,000	8,805,040	21,918,200
Total, Forest Service	21,463,795	65,039,339	23,027,175	70,730,339	26,584,315	65,663,539
Grand total, Federal	25,244,995	65,708,759	26,884,375	71,399,759	29,374,515	65,738,539

The estimates do not contain complete expenditure figures. In minor instances the responsible agencies have not cared to make estimates beyond a five-year period. In the main, however, it is believed that the total amounts shown represent a reasonable estimate of expectancy for such a sizeable program.

SUMMARY OF ESTIMATED FEDERAL EXPENDITURES FOR 20 YEARS

Table 10 contains a summary of total Federal expenditures for the Federal Forestry Program, arranged by agencies and activities in the same manner as table 9.

The estimated expenditures are on the basis of annual averages for four 5-year periods.

Explanations of preceding tables with regard to methods of computing capital expenditures by periods, and allowances for replacements apply to table 10.

The table does not include an estimate for construction of check dams and bank protection works for control of runoff for which as much as $20,000,000 may be needed. Further investigations are necessary to obtain fully satisfactory estimates.

TABLE 10.—*Federal forestry program, estimated average annual expenditures*

[20-year period]

Agency and character of expenditure	First 5-year period		Second 5-year period		Third 5-year period		Fourth 5-year period	
	Current	Capital	Current	Capital	Current	Capital	Current	Capital
Department of the Interior								
Indian Service,[1] management	$695, 000	$573, 000	$695, 000	$65, 000	----	----	----	----
National Park Service, protection	238, 200	96, 420	313, 200	10, 000	----	----	----	----
Department of Commerce								
Bureau of Fisheries, management and investigations	100, 000	----	150, 000	----	$75, 000	----	$75, 000	----
Department of Agriculture								
Weather Bureau:								
Research	44, 000	----	50, 000	----	50, 000	----	50, 000	----
Forest fire weather warnings	45, 000	----	45, 000	----	45, 000	----	45, 000	----
Plant quarantine, aid	700, 000	----	700, 000	----	700, 000	----	700, 000	----
Plant Industry:								
Aid	636, 200	----	----	----	----	----	----	----
Research	233, 800	----	----	----	----	----	----	----
Disease control on Federal land	203, 000	----	----	----	----	----	----	----
Extension Service, aid (farm) forest extension	150, 000	----	245, 000	----	250, 000	----	250, 000	----
Bureau of Entomology, research	308, 000	----	350, 000	----	350, 000	----	350, 000	----
Biological Survey:								
Research	111, 000	----	150, 000	----	150, 000	----	150, 000	----
Rodent control on national forests	116, 000	----	92, 000	----	62, 000	----	62, 000	----
Forest Service:								
Aid:								
Fire protection	3, 246, 500	----	3, 703, 500	----	3, 703, 500	----	3, 703, 500	----
Forest planting	225, 000	----	287, 500	----	350, 000	----	385, 500	----
Insect control	150, 000	----	250, 000	----	250, 000	----	250, 000	----
Forest extension	200, 000	----	360, 000	----	375, 000	----	375, 000	----
Research	3, 318, 000	----	4, 597, 000	----	----	----	----	----
Acquisition	----	29, 464, 650	----	29, 464, 650	----	$19, 464, 650	----	$19, 464, 650
Management existing national forests	8, 272, 275	17, 250, 689	8, 581, 275	14, 280, 689	8, 691, 275	4, 465, 000	8, 691, 275	4, 465, 000
Management extension, national forest system	3, 950, 640	13, 489, 800	8, 805, 040	21, 918, 200	12, 052, 940	13, 352, 000	14, 229, 840	2, 500, 000
Total, Forest Service	19, 362, 415	60, 205, 139	26, 584, 315	65, 663, 539	25, 422, 715	37, 281, 650	27, 635, 115	26, 429, 650
Grand total, Federal	22, 942, 615	60, 874, 559	29, 374, 515	65, 738, 539	27, 104, 715	37, 281, 650	29, 317, 115	26, 429, 650

---

[1] These expenditure figures are based on the assumption that the area of forest land under the jurisdiction of the Forestry Branch of the Indian Service will not vary to any appreciable extent in the period under consideration.

SUMMARY OF LEGISLATION NEEDED FOR THE FEDERAL PROGRAM

NATIONAL FOREST LAND ACQUISITION

Authorization covering a period of not less than 10 years, with an annual authorization of $30,000,000, made available until expended. Stumpage purchases it is estimated would require $10,000,000 of the above amount. It is suggested that a plan might be worked out for the stumpage purchases, whereby the Federal Government would purchase the stumpage but would defer payment for a period not to exceed 20 years, until the stumpage is cut.

An act to permit exchanges of private lands within 6 miles of the exterior boundaries of any existing national forest.

Legislative action providing for the addition to the national forests of about 22 million acres of public domain lands.

ADMINISTRATION AND MANAGEMENT OF THE NATIONAL FORESTS

It might be advantageous in financing the management and administration of the existing and proposed national forests if the program received congressional sanction as a long-term authorization. This plan should be given further consideration.

Legislation needed to establish and protect the recreational resources of the national forests includes the following:

(1) Legal recognition of recreation as a national forest resource to be developed.

(2) Authorization for the development and regulation of camp-site areas.

(3) Amendment to present legislation to allow granting of term permits for areas up to 80 acres. The present limitation is 5 acres.

All of the legislation concerning recreation needs is embodied in a bill (H.R. 58) introduced in the House of Representatives March 9, 1933, and now pending before the Seventy-third Congress.

RESEARCH

Amendment of the McSweeney-McNary Act (45 Stat. 699) to authorize erosion and stream-flow research and to authorize annual appropriations of not less than $500,000. Such legislation has been introduced in the House of Representatives, Seventy-second Congress (H.R. 4608).

An amendment to the McSweeney-McNary Act (45 Stat. 699) authorizing an increase in annual appropriations for the Forest Survey up to $500,000, and up to $200,000 for keeping data current after the completion of the initial survey.

Either as an amendment to the McSweeney-McNary Act or as a part of general legislation, to provide for the forest-land phase of land classification and including an annual authorization of not less than $300,000 for this purpose.

Legislative authority for the establishment of a seed-testing and certification station, and authorization for an annual appropriation of not to exceed $50,000 for this purpose.

AID TO STATES AND PRIVATE OWNERS

An amendment to section 4 of the Clarke-McNary Act (43 Stat. 653) to broaden the scope of the act so that its provisions for aid in forest planting will benefit all landowners and to provide for increasing from $100,000 to $350,000 the amount that may be appropriated annually for this purpose.

An amendment to section 5 of the Clarke-McNary Act (43 Stat. 653) to broaden the scope of the act so that its provisions for forest extension will benefit all landowners. It should also provide for increasing from $100,000 to $400,000 the amount that may be appropriated annually for aid to the States in carrying on State extension work, of which $150,000 should be made available to the Forest Service for work with timber land owners other than farmers, and also authorize an additional $225,000 for direct expenditure by the Forest Service in forest extension work.

An amendment to the Clarke-McNary Act to provide for cooperative financial aid to States and private owners in the control of insect attacks upon State and private forests, and authorization for expenditure of funds for the purpose to the extent of $250,000 annually.

Legislation is needed authorizing the Bureau of Plant Industry, through its Blister Rust Division, to cooperate in the control of forest diseases, other than the white pine blister rust disease.

INDIAN RESERVATION FOREST LANDS

Needed legislation for Indian reservation forest land should provide: (1) For discontinuing the present practice of allotting forest and range lands to individual Indians; (2) for the creation by law of Indian forests on the several reservations having large areas of tribal land; and (3) increased appropriations for all forestry work.

WILD LIFE CONSERVATION

Legislation authorizing the Secretary of Agriculture and the Secretary of Commerce to provide expert assistance to Federal, State, and other agencies in rearing, stocking, and increasing the supply of game and fur-bearing animals and fish; in combating disease, and in developing a Nation-wide program of game conservation, and rehabilitation, and to cooperate with such agencies to that end. Such legislation is embodied in "An act to promote the conservation of wild life, fish and game, and other purposes" (S. 263, 72d Cong.), passed by the Senate December 17, 1931.

Legislation providing for consideration of the effect of the construction of any public works or improvements upon the replacement and conservation of wild life, embodied in a bill, S. 5813, Seventy-first Congress, passed by the Senate January 26, 1931.

FINANCING THE PROGRAM

The expenditures needed to carry out the foregoing program fall into two classes, which suggest and perhaps indicate different methods of financing. Except for very small holdings such as farmer's woodlots, forestry involves the setting up of organized forest units, each of which is a going business project in itself. As such it is run like any other business, and is subject to the same general system of finance and accounting. Disbursements are either current expenditures or capital investment, depending on whether they are a part of carrying on every-day productive business or are a means of increasing the capital assets. For example, the costs of fire protection, of logging and milling, of repairs and maintenance, are current expenditures. The costs of planting vacant land, of a new road, of the purchase of additional land, or of constructing a planing mill represent additions to assets and as such are capital investments. Capital expenses add to the value of the business, so that it will thereafter become more productive and will eventually return the added investment with interest and a profit. Current expenses are recovered out of current income as a part of the cost of the goods sold. This leads to the universal business practice, once a project is organized and on a producing basis, of meeting current costs out of current income and of considering capital expenditures as investments to be met from surplus set aside from profits or from borrowed money.

FINANCING OF CAPITAL EXPENDITURES

FEDERAL GOVERNMENT

An analysis of the Federal Government's estimated part of the cost of this program divided between average annual current and capital expenditures for four 5-year periods, has been given in table 7.

There is no doubt of the soundness of the principle of financing current expenses from Treasury income by annual appropriation of funds. This has always been the practice in governmental business as well as in corporation financing. The Government, however, has generally also financed capital expenditures in the same manner, without distinguishing them in any way either in appropriations or in later accounting. This is, of course, good practice so long as the funds to be raised are within the annual Treasury income. But when strict adherence to this concept leads to the abandonment or curtailing of desirable going projects, because of a slump in Treasury income; or when increased expenditures for investment in needed improvement or facilities that beyond the immediate capacity of Treasury income must be indefinitely delayed; then it is time to consider the use of borrowed capital.

The Federal program involves the purchase of 134 million acres of forest land in the next 20 years, the planting of a part of this land, and the construction of roads and trails, fire-lookout towers, telephone lines, houses and other improvements at an average annual capital cost for the first 10 years of around 63 million dollars and for a second 10-year period of around 31 million dollars. Both the main financial and intangible returns from this investment will accrue to a following generation of Americans who will harvest the forest crop now being started. The major money income from the investment will thus commence to materialize in from 20 to 40 years after initiation and will reach its maximum in from 50 to 80 years, depending upon the section of the country involved.

This suggests that money might be borrowed for a term of years corresponding to the average financial rotation of the forests, that is, the period of growth up to the time when it is most profitable to cut the timber. This would provide a means of liquidating the principal of the loan from current returns at the time of harvesting.

A financial plan for the capital needs of the Federal Government might be worked out that would involve:

(1) Authorization to the Treasury to issue 30-year, 3-percent, forest-development bonds in each of the next 10 years as called for by the Secretary of Agriculture, and not exceed a specified amount in any one year.

(2) Provision for the retirement of these bonds at an amortization rate of 2 percent per annum which would redeem all the bonds during the next 40 years.

(3) Payment of interest and amortization expense out of Treasury receipts each year as a part of current expenses.

While financing by the issuance of bonds would, in the end, cost somewhat more than it would by the annual appropriation on the pay-as-you-go basis, the advantages are threefold: first, it would allow the prompt initiation of the plan even though Treasury funds might not at once be available; second, it would guarantee and stabilize the financing of the project in a manner highly desirable in a a long-time plan; and third, it would place the greater part of the amortization on the period of time during which the income from the investment would be greatest.

STATE GOVERNMENTS

The same general principles of public finance may be readily applied to the porposed State forestry program. Although some States with ample incomes have adopted the pay-as-you-go system, it is recognized as a sound business principle to pay for current expenditures from current income or treasury surpluses, and to finance capital investments from borrowed money. However, the scope of the forest problem varies from State to State, as well as the sources of wealth, so that no general proposal can be made to meet conditions in all States.

The capital investments of the forestry program include the acquisition of State forests, and the permanent improvements thereon that increase the value of the property and add to its productivity. Since the acquisition and development of State forests is largely a self-liquidating investment which will be of greatest benefit to future generations, it appears fair and logical to expect future generations to help pay for them. For this reason it is suggested that capital investments might be made from borrowed capital; for instance, 30-year, 3-percent bonds with a 2-percent amortization rate.

The States have already explored and developed the field of financing by borrowing, and in most instances have determined the methods best adapted to individual needs and to conditions of the existing financial structure of the States.

From the previous tables it will be noted that for the first 10-year period current expenses amount to approximately one third of the total expenditures required, and that in no instance do current expenses exceed an annual average of $300,000 for each of the 48 States. Of course, the expenses will not be evenly divided, because the States with the major forest problems will naturally carry a proportionately large share of the expenditures. However, when it is considered that the total expense in any one State may be divided among the many units of State and local government, it becomes apparent that in many instances current expenditures can be met from current treasury resources with little difficulty. Federal aid—financial and through the establishment of national forests—is expected to be greatest in those States least able to finance their forestry program.

FINANCING CURRENT EXPENDITURES

As stated before the current expenditures involved in Federal, State, and private operations will broadly include the annual disbursements for protection, administration, cultural operations, surveys and plans, forestry extension, and harvesting costs. Such disbursements in private business practices are usually met either from current income, from surplus in the event and to the extent that current income is insufficient, or from working capital borrowed on short-time loans anticipating current income.

In the case of governmental agencies, these expenditures are usually met from appropriations of funds against actual or expected treasury income. Deficiencies in income and sums needed prior to realization of income are met from treasury surplus or by short-term borrowings on warrants or on treasury certificates. There is no reason to question the soundness of this method of financing and thus no occasion to suggest any departures.

THE OFFSETS TO TREASURY DRAIN

FEDERAL FORESTS

The outlay required for the protection and management of the national forests must for some years to come exceed the Treasury income from this source. If it were possible, however, to express the dollar value of forests in the form of conservation of water, soil, recreational resources, forest ranges, and timber there would be no such deficit.

Of the 140 million acres of land in the national forests of the continental United States alone, 75 million acres are covered by commercial forest growth and of these only 7 or 8 million acres are so situated as to be available for immediate intensive management involving full realization of timber values. Sixty-five million acres of national-forest land are above timber line, or are covered with noncommercial brush, scrub growth, and open lands. This area is essential for the maintenance of water and other services and values and requires and justifies the expenditure of money to protect, but it holds no immediate promise of financial returns sufficient to meet expenses.

The commercial timber land area now inaccessible for use will gradually come into intensive development as the demand for timber increases, and in the meantime it must be given protection. All of this means that the cost of managing the whole property will temporarily exceed the immediate income from the relatively small area that can produce high returns. The acquisition program set out here provides for the addition of 90 billion feet board measure of commercial timber in the next 10 years. With this addition, plus about 40 million acres of the 75 million acres of commercial timberland now in Federal ownership, for which demand can be expected to develop within 20 years, the possibilities of financial return takes on an entirely different aspect.

The average annual cost, chargeable to current expenses, of the first 10 years of the Federal part of the program is around $26,000,000. There is no question, of course, of the Treasury's ability to meet such a relatively small expenditure annually by appropriation from income. By the end of 20 years, if the program is carried out as planned, an annual gross yield of $160,000,000 worth of marketable products or services might be possible. This is not a forecast of expected returns, but is rather a measure of the value, in place, of the timber and other products that should be available for utilization annually under the management and with the facilities provided for.

Just what part of this annual production can be converted into fiscal receipts it is impossible to forecast 20 years in advance. The studies of forest growth and of trends in requirements point convincingly to a total production by the end of 20 years of less than our needs, and it appears not unreasonable to anticipate a market for most, if not all, of what can be produced on the national forests.

The national forests of the future as balanced by the addition of commercial forest areas to present areas, and as improved and made marketable by the facilities and cultural operations planned, should ultimately pay their way and more.

STATE FORESTS

For the State, as for the Federal Government, if it were possible to determine the actual money value of forests in the conservation of water, soil, wild life, and recreational resources, these services alone would justify their investment. There are, in addition, many sources of direct income from State and private forests, which contribute to the public treasury to offset the drain of initiating their establishment and development.

As timber crops mature under adequate protection and proper silvicultural management, a very considerable income may be expected from the sale of timber products. The returns will vary according to the character of the forest; certain areas of low productivity required for watershed protection may return no income, whereas other areas of high productivity may yield net returns of several dollars per acre per year. After the initial period of their establishment and development, State forests may be expected to return many times the amount of their current carrying charges.

OTHER SOURCES OF TREASURY INCOME

FROM NATIONAL FORESTS

As a means of financing immediate expenditures, there are other possible sources of Treasury income that should be considered. Upon the principle that the chief beneficiaries of the management proposed should bear a share of the cost roughly commensurate with the special benefits enjoyed, one must take into account the industries and communities that use water on a large scale, such as hydroelectric power companies and municipal water users, as well as those engaging in traffic on the navigable rivers and inland waterways.

All of these benefit greatly and uniquely from the water-conservation and flood-control effects of managed forests—especially those on drainages of major interstate streams.

In 1931 the production of electricity from water power was 30,603,000,000 kilowatt-hours, about a third of the total electric current produced from all sources. The gross sales value of the current at an average of 2 cents per kilowatt-hour is roughly estimated at $600,000,000 per annum. An excise tax of 2 percent on gross sales would produce now around $12,000,000 annually. Probably with complete development of the water power resources of the whole country the installed capacity would amount to 80 million horsepower or more. This is more than five times the present developed horsepower and indicates the possibilities of this source of tax income.

Our urban population is, according to the last census, about 69 million. It is estimated that cities and towns consume 1,800 billion gallons of water for domestic and industrial uses annually. The greater part of this water is taken from streams and the quantity and purity of the supply depends largely on the maintenance of forest cover on the watersheds. It is difficult to appraise the money value of this service of forests but the magnitude of the possibilities of income will be realized when so small a rate as 1 cent per thousand gallons would produce $18,000,000 annually.

The commerce carried on the principal rivers and fresh-water canals of the United States in 1929, not including commerce on the Great Lakes, aggregated 130 million tons of freight. The probable increase in this freight traffic may lead to as great an annual business as 500 million tons by the end of 20 years. The development of water-borne commerce on our inland streams depends in large part on the control of run-off at headwaters and upon checking the silting up of channels caused by erosion of watersheds. In both of these cases forests play an important part, and it does not seem illogical to charge this business with a share of the cost of forestry.

It is apparent that in dealing with charges or taxes on water-power development, or water used for domestic or industrial purposes in cities and towns, and on water-borne traffic, there are legal, constitutional, and economic questions to be solved which are beyond anything attempted in this report. Nevertheless these are special beneficiaries of forestry and the field is of such magnitude as a source of Treasury income that it is worthy of consideration.

One of the possibilities for increasing Treasury income from Federal forests lies in licensing the large and rapidly growing recreational use. In 1931, 32 million persons from all parts of the United States visited the national forests. Some of these undoubtedly were entirely transient travelers, many of whom were probably counted more than once. Millions of persons, however, spent one or more days in the national forests in camping and hunting or fishing. At present there is no charge of any kind for this use of the forests, although the Forest Service has for years had to use an appreciable part of its funds to employ personnel and maintain facilities to care for this traffic. In addition it has been necessary to increase fire protection to meet the materially augmented fire hazard introduced. A hunting, fishing, and camping permit or license costing $2 per person per season would work no hardship on individuals and should bring in an additional income of many millions of dollars.

FROM STATE FORESTS

Upon the principle that those who use the forest and who benefit directly from it should help to defray its expenses, game and recreational facilities become possible sources of forest income for the States also. The States now derive considerable revenue from the sale of hunting and fishing licenses; it appears not illogical to suggest that part of these funds should be devoted to the maintenance of the forest cover upon which wild life depends to a large measure for food and shelter. Nominal charges for the recreational use of State forests is already recognized in some States as a legitimate source of income.

The development of hydroelectric power, of most potable water supplies, and of commercial water navigation, is dependent in a large measure upon the regulation of stream flow from forested watersheds. Therefore, it would appear equitable to help pay the costs of forest protection and administration by some system of water taxation.

The expenditure of public funds for forestry, particularly through State aid to private owners, contributes directly to increased State income. As private forest lands are kept productive, and as profitable forest industries are maintained, the entire tax base is widened and the income from taxation is increased. By the establishment of State or other public forests in backward regions, with the abandonment of decadent communities and costly public improvements no longer necessary in those regions, large savings of public funds may be made. These savings may contribute very greatly to the accomplishment of the State forestry program.

APPENDIX

APPENDIX

FOREST CONDITIONS AND FOREST PROBLEMS IN ALASKA AND PUERTO RICO

ALASKA

B. F. Heintzleman, Assistant Regional Forester, Alaska Region

The forests of Alaska which will contribute to the general timber supply of the Nation are confined to a narrow mainland strip and islands adjacent, extending for 800 miles from the British Columbia boundary northwest to the entrance of Cook Inlet. The forest type is an extension of that found on the coast of Oregon, Washington, and British Columbia, and consists of heavy dense stands of conifers, principally western hemlock and Sitka spruce with some intermixed western red cedar and Alaska cedar. This type is known as the "coast forest." Its presence on the relatively small section of Alaska mentioned above is due to the warm Japan current which reaches this shore line and serves to moderate the temperature and provide a heavy precipitation.

The total area of commercial timberland in the coast-forest type is somewhat more than 6 million acres. Practically all of this is owned by the Federal Government, with more than 98 per cent in national forests and most of the remainder open public domain. The amount of privately owned timberland in Alaska, both in the coast forest and other forest types, is negligible.

Aside from this coast-forest area Alaska has the vegetative cover types common to the whole extreme northern portio of the American continent from the Atlantic to the Pacific. The Arctic Ocean drainage areas and the littoral of Bering Sea for a width of 100 to 150 miles are almost wholly treeless, the covering being tundra. The Alaska Peninsula and its extension, the Aleutian Island Chain, are grass-covered. The remainder, which constitutes the major portion of the Territory, is covered with a patchlike arrangement of types embracing coarse grass, brush, tundra, and peat moss, all of which may have some stunted black spruce of pole size; scattered limby trees of white spruce, white birch and cottonwood with intermixed brush; and dense stands of small slow-growing trees of the above species. The last two types, which are the true forest types, constitute the "interior forest."

The interior forest is a highly important factor in the upbuilding and maintenance of populous and prosperous communities throughout vast sections of the Territory, but it will not be drawn on to supply any material amount of products for the general markets of the United States.

No field surveys have been made to determine the extent of the interior forest but information from many sources indicates that it covers in the aggregate perhaps 100 million acres, of which as much as 40 million acres is in dense (closed) stands with trees of good timber form though of very small size. The interior forest has suffered severely from forest fires since the coming of the white man, the original area of dense forest being materially greater than at present. Practically all of these interior-forest lands, as well as the nonforested lands, are open public domain of the Unite States.

THE COAST FOREST

The 6 million acres of western hemlock-Sitka spruce forests on the southern coast of Alaska contain around 80 billion board feet in stands having trees predominantly of sawtimber size and 8 million cords in stands classified as cordwood. The average stand per acre is around 16,000 board feet, and the trees average about 2 feet in diameter and 80 to 100 feet in height. The timber is thus not so heavy as that of the corresponding forest type in Oregon and Washington, and in addition it contains a higher percentage of defect, as well as less clear stock. The Alaska timber is readily accessible, since it is confined to the lower slopes and adjoins a greatly indented shoreline and a net work of sheltered waterways.

The virgin timber of this region is virtually still intact. Fire has done little damage owing to a heavy precipitation well distributed throughout the year and utilization has been but a small fraction of the possible sustained output under forest management. The present rate of cutting is less than 50 million board feet yearly and the total amount removed since 1900 is about one billion board feet; but studies of the tree growth indicate that fully one billion board feet could be cut yearly without depleting the future supply.

The present output of the forest is used almost exclusively to supply local needs with the leading industries, fishing and mining, accounting for most of it. Efficient modern sawmills producing a great variety of products are within reach but only the highest grades of lumber can economically be sent into the general markets outside the Territory and these constitute a small percentage of the mill output.

The development of an extensive sawmill industry in these Alaska forests is considered inadvisable in view of the better opportunities for lumber production in the forests of Oregon and Washington, with which it would have to compete, and because of the outstanding chances for paper production, especially newsprint, in Alaska. Local lumber production should properly be gauged to the local lumber demand, and only the high grade lumber not salable locally going to the general markets of the United States. This excess for the general markets would approximately balance shipments of special lumber orders going into Alaska, and the Territorial production or consumption would therefore affect very little the general lumber situation of the United States.

The Forest Service, administering over 98 percent of the timber volume of the coast forest of Alaska as a resource of the Tongass and Chugach National Forests, is committed to the policy of managing this forest land for the production of pulp and paper, since conditions are more favorable to such use than any other. The natural advantages for pulp and paper making appear sufficient to allow of successful competition with other large pulp and paper manufacturing localities in the United States and foreign countries.

The Forest Service will manage these pulpwood forests under an adequate system of sustained yield and also limit the development of the local pulp and paper industry to a total woodusing capacity that can be supplied indefinitely through the growth. Studies made to date indicate a forest rotation period of 90 years with an output of wood within the first rotation period sufficient to produce 1 million tons of newsprint paper yearly. The second and subsequent periods should have a materially higher output as the new forests grown under management should be heavier in volume per acre than the present virgin forest with its extensive overmature and somewhat broken stands.

The average yearly consumption of newsprint in the past five years in the United States has been 3,500,000 tons, of which 2,180,000 tons, or 62 percent, was produced in Canada and other foreign countries. With a possible sustained output of 1,000,000 tons Alaska can be a material factor both in contributing to the total available supply for the United States and in increasing the percentage of the country's requirements which is produced on home soil. The pulp and paper industry has not yet been established in Alaska.

THE INTERIOR FOREST

The timber on the dense forest areas of the interior consists of a mixed stand of any two or all of the three species, white spruce, white birch and cottonwood. Most of the trees are less than 12 inches in diameter and the average is not over 8 inches. White spruce frequently reaches a diameter of 18 to 24 inches, which is sufficiently large for sawlogs, but as these larger trees occur as individuals scattered throughout the smaller timber and as the principal forest products are and will continue to be material in the round and in corewood form, the volume of standing timber is best expressed in cords. The average stand per acre is estimated as 10 cords, giving a total volume of 400 million cords for the estimated area, 40 million acres. No satisfactory estimate can be made of the usable material available in the very extensive type consisting of scattered trees and brush and the total volume of the interior forest should be considered as that given above for the dense stands.

Timber cutting has been confined to supplying material for local purposes and while the aggregate so far removed from the forest has been large it is a negligible percentage of the total available. At the same time, fires and heavy cutting around some of the settlements have about exhausted the supply of readily accessible material at those places.

The per capita consumption of timber in interior Alaska is very high even for a frontier country as practically all activities are heavy wood users. One of the principal uses is for fuel during the long and intensely cold winters. Wood-burning river steamers and mining operations also make unusually heavy demands. Sawmill utilization is small with one plant at Fairbanks cutting 25,000 board feet daily during the summer season and three other commercial plants of much smaller size operating intermittently. Many small portable mills are operated by mining companies at intervals to produce sawn material for their individual use.

The use of the timber resources in material quantities began about 1900 when the discovery of rich gold placers started an influx of miners, totaling tens of thousands, to interior Alaska. By 1910 the gold rush period was past and a large percentage of the miners had left the country. The permanent population has grown very slowly in the past 22 years and within the sections where the interior forest exists is now about 18,000. Consequently, the yearly consumption of wood has not been increasing materially and may even have decreased in the past 10 years or since the construction of the Alaska Railroad, which has made the local coal available to the more populous communities.

The possibilities for future general development in interior Alaska are based on metal mining, coal mining, reindeer grazing, fur trapping, fur farming, big game hunting, tourists, and agriculture. Estimates of available lands satisfactory for agriculture run as high as 42 million acres, but farming is likely to be confined to supplying Alaska markets and its growth would thus be dependent on the expansion of the other activities named above. The settlement of this region may proceed quite slowly because of its isolation, but it is only reasonable to expect that eventually interior Alaska will have a population and an industrial development more nearly commensurate with its available resources. Norway, Sweden, and sections of other countries in the same latitude as Alaska support fairly dense populations.

Very little timber from the interior forest will be used for products going into the general markets of the United States or foreign countries, but local activities will need increasingly large quantities and these forests are of inestimable value for supplying such requirements. With a light stand per acre and very slow rate of growth the perpetuation of the existing forests on all lands not needed for other purposes is essential in order to have the required timber supplies available.

Another highly important value of the forest lies in the cover afforded and the direct and indirect food supplies provided for game and fur-bearing animals. The timber and woodland areas of Alaska contain important resources in game birds and animals, in fur bearers, and in forage resources for reindeer and caribou. The areas suitable to reindeer have been thoroughly investigated by the officers of the Biological Survey resident in Alaska. The Survey acts in an advisory capacity to the Governor of Alaska, who has the responsibility for the general management of the reindeer resources. Birds and game, including grouse, ptarmigan, waterfowl, moose, deer, caribou, mountain sheep, bears, and rabbits, are of extreme importance as a source of food for pioneers and prospectors. The annual output of fur from Alaska, valued at more than $4,000,000 in 1928 and 1929, but matetially less in 1930 and 1931, constitutes the chief source of revenue for the scattered population over many parts of the interior. Continued trapping has reduced the number of the fur bearers—otter, mink, marten, weasel, fox, lynx, muskrats, and beavers—to the point where it has been necessary to adopt vigorous protective measures. The Alaska Game Commission has been organized for the purpose and restrictive regulations adopted. It is generally recognized, however, that forest fires by destroying the shelter and food for these fur bearers, as well as for birds and game, and by killing them outright, do tremendous damage to this important resource. Similarly grazing values are affected adversely. Biologists tell us that it takes many years to again grow the lichens or reindeer moss, so important to the reindeer industry as well as big game, after it has been burned.

The interior forest has a high fire risk and losses have been heavy. The annual precipitation is less than 16 inches and the forest becomes very dry during the short warm summer of almost continuous daylight. All fires are man made. Lightning is not a menace. An estimate of the area burned and the damage done can be little more than a guess as no field studies have ever been made, but according to the general observations of those who know the country, enormous areas of both forest and tundra have been burned over in the past 30 years and the yearly losses are still very heavy.

From the early gold-rush days the great majority of the local inhabitants has been at best apathetic regarding fire but the last 5 years have been a small but growing sentiment in favor of protection, owing in large part to a greater appreciation of fire damage to such natural resources as big game, fur bearers, reindeer forage, and game birds, and to a realization of the extra cost and inconvenience experienced when a local supply of timber for settlement and industry has been wiped out. The dissatisfaction of tourists over the screening of the scenery with a heavy pall of smoke has also been a factor. A campaign of educational work could likely extend and strengthen this sentiment very easily. Owing to the small population almost every local inhabitant could be reached in person.

The interior forest has practically no fire protection. The General Land Office of the Department of the Interior spends a few thousand dollars yearly on suppression and the Government-owned Alaska Railroad gives attention to prevention and suppression of fire on its right of way but further than this nothing is done by the Federal Government, Territory, or other public agency, or by private corporations. There are no organized detection and suppression forces, no intensive and systematic educational work is being done, and no survey is made of fire losses.

RECOMMENDATIONS

The great bulk of the timber of the coast forest is included in the national forest system and is so administered as to keep the lands continuously productive and provide a sustained yearly output of timber products. The only changes which need to be made are those common to all national forests.

A satisfactory fire prevention, detection, and suppression organization is needed on the interior forest and tundra lands. This should be established by the Federal Government, as the owner of the public domain, which includes virtually all the land of the region. The protective organization could be small in comparison with the area to be covered due to a scant population and the fact that all fires are man made. Good cooperation at little expense could be furnished by representatives of various branches of the Federal Government who are stationed at many places throughout the region.

As a basis for establishing a fire-protection system an extended field study should be made of the problem. This should cover such features as: (1) The extent and value of forest and tundra resources in relation to present and future local needs; (2) damage by fire, past and present, on forest and tundra lands; (3) localities in which fire protective measures are justified; (4) kind, size, and cost of the protection organization needed.

This reconnaissance survey of interior Alaska, necessary as a preliminary to establishing organized fire protection in this territory, would be made largely by airplane, and would require about 3 years. The survey and the fire-preventive organization are estimated to cost $50,000 a year.

Fire protection is the only important forestry measure for the interior forest which appears to be justifiable at this time. It is doubtful if any system of intensive forest management will be justifiable in view of the slow growth and small size of the trees and the restricted markets for a long time to come.

PUERTO RICO

By R. M. Evans, Assistant Regional Forester Eastern Region

Puerto Rico is very sparsely wooded. The impenetrable forest jungles, commonly associated with the West Indies, are so scarce that one may cross and recross the island without seeing them, for, with the exception of those in the Sierra de Luquillo, they are tucked away in the more inaccessible places into which few except the "jibaro" ever penetrate. The island is, however, by no means devoid of wood growth. Around almost every habitation there are groups of trees, and numerous scattered trees dot the open landscape. The protective cover of shade trees of the coffee plantations gives a decidedly forested appearance to many localities.

Puerto Rico presents an unusual combination of physical and economic conditions. The insular and geographic position of the country, its small size, its restricted area of level lands, and its density of population, to mention but a few of many influences, have occasioned unusual demands on the forests. The same cycle of change is found here as is recorded by civilization everywhere—a profligate waste and despoliation of the bounties of nature, followed by an acute need for what has been destroyed.

Puerto Rico is the eastermost and smallest of the Greater Antilles. It is approximately 100 miles long and 35 miles wide and is remarkably rectangular in outline. Its area is approximately 3,435 square miles, or 2,200,000 acres. Puerto Rico and the other islands of the Antilles and Central America and northern South America were formerly. according to geologists, a united and distinct continental land mass—the Antillean Continent.

Puerto Rico embraces three main physiographic regions—a central mountainous core of volcanic origin, an elevated area of coral limestone surrounding the mountainous portion, and the coastal plain. The central mountainous area occupies by far the largest portion of the island; it is also the most important from the standpoint of the island's forests. Viewed from the sea, it presents a rugged and serrated aspect; numerous peaks and summits, with no definite crest line, rise from a general mass, which has been cut by erosion into lateral ridges, separated by deep, steep-sided gorges.

The Sierra de Luquillo, the most easterly of the three ranges making up the central mountains, is nearly surrounded by low coastal plains and is practically isolated. The remaining mountain mass forms an uninterrupted expanse of broken uplands. The eastward portion is known as the Sierra de Cayey; that to the west, the Cordillera Central. This region has an average elevation of about 2,500 feet, above which the higher peaks project irregularly, a few to an elevation of more than 3,500 feet.

As a result of the almost uninterrupted action of abundant precipitation, a high relative humidity, and a warm temperature, rock weathering at the higher elevations is more rapid than erosion, as shown by a soil mantle of unusual depth and almost no bare rock. The characteristic soils are deep, reddish clay loams and tenacious red clays. So cohesive, unctuous, and compact are these soils that they are able to maintain themselves in an almost vertical position. Cultivation, in consequence, is in many places carried on to the very tops of the ridges and on the steepest slopes, yet evidence of gullying and landslides in the high country is surprisingly inconspicuous. Sheet erosion, which removes the top layers of the soil, is common, but ordinarily escapes notice.

There can be little doubt that at one time Puerto Rico was completely forested. Following the Spanish settlement, early in the sixteenth century, land passed rapidly into the hands of private owners. Final clearings, severe burning, and the previous cutting of the more desirable timber trees, all in preparation for the planting of coffee, tobacco, cane, or other crops, continuing over a long period of time, has resulted in the present naked state of the island's hills and valleys. The valleys and other topographically suited and fertile areas have been justly devoted to tillage or coffee growing; but there remain today approximately 1,100,000 acres of forest, brush, swamp, and barren lands of which but an insignificant part contains forest growth of economic value. According to statistics of the Department of Agriculture and Labor of Puerto Rico, the land area of the island is classified approximately as follows:

	Acres	Percent
Cultivated land	550, 000	25
Pasture or grass land	550, 000	25
Forest, brush, or waste land	1, 100, 000	50
Total	2, 200, 000	100

The "conuco" system of farming, a shifting method of agriculture employed by primitive people throughout the tropics, is responsible for much of Puerto Rico's deplorable forest condition. Years of cutting, burning, and clearing succeeded by the planting of some small food crop, continuously cultivated until the surface soil is worn out (usually in 3 to 4 seasons), followed by complete abandonment of the plot to grass, weeds, and other volunteer growth, is the cycle of operations which has caused the present barren and exposed state of thousands of acres. Charcoaling, an adjunct of "conuco" farming, is a further factor contributing to the deforested condition of the land.

Of the once unbroken tropical forest there now remain only isolated remnants scattered over the island in its most mountainous parts.

The best known of these, and the largest as well, covers about 12,000 acres of the Luquillo Range and is now under Federal management. The aggregate of all the other remnants is believed to be well within 5,000 acres, making the total area of original forest less than 1 percent of the total land area. The Insular Forest Service estimates that Puerto Rico has not more than one eighth of its area in growing forests of any kind, including the areas under coffee culture.

Of the 1,100,000 acres in the third classification above, there are about 400,000 acres which have been assessed as "timber and brush lands" and a few thousand acres more classed as swamps and largely under mangrove. Of the "timber and brush" areas, the bulk are found in the southern, southeastern, and southwestern parts of the island. Insular authorities estimate that altogether 400,000 to 450,000 acres are unsuited to profitable agricultural use and should be kept perpetually in forest.

About 95 percent of the land area is in private ownership. Of the less than 130,000 acres remaining in public ownership, by far the greater part lies in the mountains. Federally owned lands within the Luquillo National Forest amount to 13,885 acres. Insular forests account for about 40,000 acres, of which 25,000 acres are in the uplands and 15,000 acres in mangrove swamps. Thus, less than 54,000 acres of the public lands are under definite control and management.

Forests make their presence felt through their influence on climate, on stream flow, and on soil erosion. In a country as abundantly watered as Puerto Rico whether the forests cause slightly more rain in the aggregate matters little. The most important influence of the forest is in the checking of floods and erosion, though the conditions in Puerto Rico are such as to make the control of floods by forestation alone impossible. Throughout a greater part of the year the forest soils in the mountains are nearly, if not quite, saturated with moisture. Steep slopes and rain in the form of brief but torrential downpours are the rule and complete a combination favorable to most rapid run-off. These make it necessary to supplement forestation by a succession of reservoirs and a cleaning up of the channels if any noticeable reduction of the eroding effects of floods is to be accomplished.

Forests aid in conserving the water in the soil. The trees increase enormously the amount of water that goes into the soil instead of running off on the surface and then help the soil to retain it.

Forests influence erosion in two ways: By reducing the force and interrupting the passage of the run-off in the catchment areas around the headwaters of the streams, they slow up the washing away of the surface layers of the soil and greatly impede gullying. At the same time, the ability of the run-off to transport eroded material is very considerably lessened.

The greatest damage is done when the run-off is gathered into the streams of the island and reaches the foothills country, wherethee heavy clays of the interior are replaced by the lighter and more readily eroded coast soils. The rivers are generally too short to choke up and overflow; yet they are continually widening and shifting their channels, cutting off islands from adjoining fields, and undermining their banks. The close relation of the existing forest cover to stream flow and erosion is not difficult to observe. For this purpose, the lower reaches of the north coast rivers, particularly those rising in the coffee district or the Luquillo, may be compared with the south coast rivers. The former show relatively few abandoned channel beds and less spreading stream bottoms, are obstructed only by sandy or gravelly bars and relatively small boulders, and maintain a reasonable flow of water even in the dry months. South side rivers, which are largely fed by the rains falling on the steep grass slopes of the Cordillera Central, have wide, dry bottoms showing often no less than six different channels separated by low islands. The boulders, which are everywhere strewn about, are several times the size of those in the north coast rivers, and in the dry months the stream is of insignificant proportions in the midst of surroundings indicative of destructive power.

In the larger commercial sense, the forests of Puerto Rico are particularly deficient. In their present condition, they neither add to the island's export trade nor provide the raw material for important local industries. They furnish only one fourth of the wood materials actually used on the island. Even as they stand, however, they are vitally important as a source of domestic wood supply.

The principal fuel of the island's 1½ million inhabitants is charcoal, of which enormous quantities are used. There is also a demand for stakes, posts, cabinet woods, and construction timbers. In normal years, Puerto Rico imports wood products to the value of 5 to 6 million dollars, much of it in the form of softwood lumber from the Southern States. Importation of this class of material will probably continue, since no pines or other softwoods are native to the island, but there appears to be no reason why the 400,000 or more acres of land unsuited to agriculture should not be made to produce such other forest material as is needed, with a surplus of valuable cabinet woods for export.

The insular government is not unmindful of its forest problems, and legislation has already been enacted which will aid greatly in remedying the deplorable condition of forest areas. Existing laws provide for—

A forest service to have custody and management of lands reserved for insular forest purposes.

An assessed valuation of $1 per acre of all areas over 5 acres in size planted with 600 trees or more per acre.

Authority for the insular department of agriculture to purchase lands for forestry purposes, at a price not in excess of $15 per acre.

Authority to establish auxiliary insular forests on private lands above 1,000 feet elevation and to exempt from all taxation lands so classified.

Authority for the Federal Government to acquire land for forstry purposes, unspecified as to amount.

The three forest nurseries of the island produce about 1½ million seedlings annually, most of which are distributed free of charge to landowners. Although the financial condition of Puerto Rico does not permit any great increase of forestry activities at present, there is a growing interest in forests on the part of the general public. Some owners who are awakening to the value of tree crops as a part of diversified agriculture are reforesting their nonagricultural lands as a business undertaking.

More than 330 tree species are native to the island, and many useful species have been introduced. On favorable sites, tree growth is rapid. In 1922 a plantation of casuarina (an imported species) was established near the village of Luquillo on the north side of the island in soil too poor to grow sugar cane. Ten years later the trees in this plantation averaged 6.1 inches in diameter breast high, and 57.5 feet in total height. The volume of wood per acre in various products amounted to 2,678 cubic feet, or 31.2 cords, or 600 poles (42 feet long), or 4,200 fence posts. This plantation had grown during the 10 years at the rate of 3.12 cords each year.

Another plantation of casuarina on the northern slopes of the Luquillo Mountains reached an average diameter breast high of 2.85 inches and an average height of 34 feet in 3 years and 11 months. In the same location mahogany averaged 1.41 inches in diameter and 11.1 feet in height at 3 years of age; cedro (*Cedrela odorata*), one of the most valuable native species, at the age of 2 years and 4 months averaged 1.71 inches in diameter and 12.8 feet in height. Many valuable native species, such as capa blanco, capa prieto, ausubo, laurel sabino, algarrobo, maria, and tabonuco, reach sizes suitable for cabinet work and construction purposes in 30 to 50 years. Fuel wood, charcoal, posts, etc., can be produced in 5 to 15 years from rapid growing native species, such as guaba, guama, and bayahonda, and from introduced species such as black wattle, tulipan, saman, and eucalyptus.

In the higher portions of the mountains, particularly on the exposed, wind-swept southern slopes, growth is slower, and a forest cover would be more difficult to establish by planting.

Informed opinion, both local and Federal, holds that lands in the central mountain ranges above 2,000 feet in elevation, totaling some 150,000 acres, should be publicly owned and kept perpetually in forest as a source of wood products and for the purpose of water and soil conservation. These lands, now mostly in private ownership, will have to be purchased, and on large areas a new forest can be established only by planting. Because of their inaccessibility, the greater difficulty and cost of planting them, and the relatively long liquidation period involved, they would hardly be attractive from the standpoint of private forest enterprise.

To acquire the bulk of these mountain lands and place them under management is perhaps the most important forestry project in the island. The Federal Government should share in it to the extent of expanding the Luquillo National Forest to a unit of 55,000 to 60,000 acres, which can be accomplished through the purchase of adjoining lands worn out or abandoned for agriculture. Authority for such purchases to a maximum of 50,000 acres was granted in 1931 by an amendment to the Clarke-McNary Act. A rough estimate of time requirements and ultimate cost suggests a 15-year program, with an appropriation of $100,000 a year for the two purposes of purchase and planting, making an aggregate budget of $1,500,000. This budget should be apportioned $600,000 to the Federal Government, which would purchase some 40,000 acres to supplement the present 14,000 acres of the Luquillo National Forest, and $900,000 to the insular government, which would purchase 60,000 or more acres to supplement the 25,000 acres of uplands already in insular forests. The costs are figured roughly at $10 per acre, on the average, for the land, and

$5 per acre for planting and seeding. By means of such a program reenforced by the work of the insular Division of Forestry, the continued cooperation of private owners, and the power of example, the island of Puerto Rico, instead of producing, as at present, only one fourth the amount of wood sufficient for her needs, should within 50 years be producing the wood needed for the industrial uses of a greatly increased population and should in addition number among her most valuable exports a considerable volume of rich cabinet woods, such as mahogany, tabonuco, ausubo, and cedro.

Under a cooperative agreement between the United States Forest Service and the Insular Department of Agriculture and Labor, of which the Division of Forestry is a unit, the Federal forest officer in charge of the Luquillo National Forest is also employed as Chief of the Puerto Rico Forest Service; thus complete cooperation in the forestry work is secured by the Federal and insular governments, and duplication of effort is avoided. This arrangement has worked well and should be continued. The public lands in charge of this officer at present consist of about 14,000 acres in the Luquillo National Forest and about 40,000 acres of insular forests, widely scattered in six forest districts, each under a guard or inspector. The service includes also the work of the three forest nurseries, the distribution of seedlings, and aid and advice in planting and forest cultural work. The present annual forestry budget amounts to about $32,000, of which the cost to the Federal Government for the administration of the Luquillo National Forest is slightly more than $2,000. The rest of the work is charged against insular funds. The ultimate annual cost of administering publicly owned land, if the acquisition and planting programs previously mentioned are consummated, should be in the neighborhood of 15 cents per acre, or about $10,000 for the Federal Government and $20,000 for the insular government.

There is urgent need for the establishment in Puerto Rico of the tropical forest experiment station already authorized by the McSweeney-McNary Act. Growth and management of Puerto Rican tree species, native and introduced, present practically a virgin field of investigation. The multiplicity of species, their complex habits and characteristics, the variable climatic factors, and the prevailing lack of basic knowledge concerning them offer many practical but unusually difficult problems. Until the basic knowledge required can be made available through the factilities of a well organized forest experiment station, progress in forestry, both public and private, will be slow. Furthermore, such a station will be of value not only to Puerto Rico; its influence should be felt in forestry matters throughout the West Indies and in tropical America.

INDEX

A — Page

- Abandoned agricultural lands:
  - Areas 164
  - Watershed problems:
    - Central States 1524
    - East Gulf 356
    - Missouri River Basin, lower 402
    - South Atlantic 349
- Abandonment:
  - Agricultural land 148, 151, 158, 164, 417
  - Cut-over land 881
  - Forest land, causes 880
  - Land, lessened by forest-fire protection 803
  - Uncut timberland 882
- Accessibility of timber. (*See* Availability.)
- Acquisition:
  - County, objects of 1158
  - Expenditures (chart) 20
  - Federal:
    - Accomplished and proposed (table) 575
    - Considerations governing 1160
    - By donation 1167
    - Effect on counties 1161
    - By land exchange 1162, 1250
    - Methods 1162
    - Objectives 1160
    - Private stumpage, future supply 1284
    - Program, national forest 574
    - Program 1173, 1300
    - By purchase 1165, 1248
    - Proposed for watershed protection 52
      - (table) 1533
    - Weeks law 1171
  - Municipal, objects of 1158
  - National forest:
    - Proposed program of 1618, 1622
      - Legislation needed for 1631
  - Public 1171
    - Accomplished and proposed (table) 1173
    - As aid to private forestry 1147
    - Of depleted land, justification for 1150
    - Economic justification for extension of 1150
    - Of forest land in national plan, summary 68
    - Future, by all agencies (table) 1298
    - Of heavily timbered lands, justification for 1151
    - Program, cost of 1299
    - Progress to date, existing programs (tables) 1264
    - Types of land desirable for 1150
    - Ultimate (table) 1295
    - Watershed areas (chart) 52, 1288–1293
  - State:
    - In process (table) 825
    - Objects of 1159
    - Program 1300, 1604
      - Expenditures involved (table) 1608
    - By purchase 1249
- Action, public, influence on permanent ownership of private industrial timberland 1266
- Administration, forest:
  - Forest recreation areas 482
  - Forest, relationship with research 655
  - National forest:
    - Cost 1104
    - Efficiency (chart) 603
  - Program, State expenditures involved 1608
  - State:
    - Lake States 834
    - Northwest 832
- Agricultural expansion, passing of 249
- Agricultural land, abandoned. (*See* Abandoned, Abandonment.)
- Agricultural land available for forestry, summary 18
- Agricultural land:
  - Factors that deter conversion from private to public 884
  - Requirements, future 162
  - Watershed conditions on 1512
- Agriculture:
  - Areas used for, formerly forested (table) 154
  - Consumer of forest products 97
  - Decreases in land used for (charts) 156–157
  - Erosion resulting from 326, 408
  - Range use of forest land 144
  - Service of forests to 98
  - Soil wastage resulting from 414
- Aid, Federal:
  - Appropriations, 1933 (table) 1053
  - Development of cooperative fire protection 1911–31 (table) 776
  - Effect on State forestry 776
  - Factors affecting 1208
  - Farm forest planting 1076
    - Distribution of trees, 1930 (table) 1079
    - Expenditures (table) 1078
  - Farm forestry extension 1081
    - Expenditures 1915–33 (table) 1082
  - Financing the system 1219
  - Fire protection 1054, 1208
    - Distribution of costs 1063
    - Distribution of expenditures (table) 1063
    - Financing of 1062
  - Forestry extension 787
  - Land grants to States 1088
  - Needed in control of tree diseases 1218
  - Needed in research 1216
  - Proposed in land acquisition by States 1219
  - Ratio of Federal to State and private funds 1221
  - Results of 1056
  - Roads 1087
  - State agricultural colleges 1092
  - State experiment stations 1092
  - Vocational education 1093
  - Woodland management 1213
- Aid, public:
  - To private owners:
    - In national plan, summary 60
    - Versus private expenditures (chart) 77
  - *See also* Public aid.
- Aid, State:
  - Analyzed by regions 1185
  - Annual cost (tables) 1178–1179
  - Clarke-McNary law 1180
  - Control of forest insects 1182
  - Cost of projects (table) 1179
  - Fire protection 803, 1180
  - Forest and economic surveys 1184
  - Forest extension 1181
  - Forest planting 1181
  - Forest research 1183
  - Forest taxation 800
  - Reforestation 798
  - Scope and functions of 1177
  - To private forest owners (charts) 1179, 1185, 1186
  - Tree-disease control 1182
- Alaska:
  - Coast forest 1642
  - Forest conditions and problems 1641
  - Interior forest 1643
  - Pulpwood supplies 201
- Algeria, regulation of private forests 1014
- Alienated lands, national forests (table) 569
- Allotted Indian forest lands, areas (table) 611
- Allotment policy, Indian lands 614
- Alternatives to national-forest system 1110
- American Association for Advancement of Science:
  - Contribution to forestry 8
  - Initiation Federal forestry activities 746, 748

Page

- American Forestry Association, contribution to forestry 8
- American Tree Association, contribution to forestry 8
- Amortization rates, forest loans 1132
- Antelope, on national forests (table) 493
- Appalachian Mountains, critical watershed problems 1527
- Appropriations:
  - Forest research (chart) 1144
  - Increases needed, management present national-forest areas 1313
  - State, for forestry 1224
  - *See also* Expenditures.
- Arboretum, national 1568
- Areas:
  - Abandoned agricultural, watershed protection, public acquisition (table) 1288
  - Abandoned farm land, future ownership 1275
  - Alienated lands, national forests (table) 569
  - Annually burned (charts) (table) 14, 1070, 1396
  - Available for:
    - Forestry, proposed distribution (chart) 1232
    - Planting (chart) 50
    - Timber use, by regions (table) 1280
  - Federal and State, in national plan 77
  - Forest:
    - Allowable burn, by agencies 1399
    - Annually burned (table) 1396
    - Available for planting (chart) 50
    - Burned annually, Indian forests 627
    - Burned annually, public and private (chart) 14
    - Burned yearly, State and private 1070
    - Commercial (chart) 127
    - County forests 847
    - Devastated annually (table) 852
    - Devastated, public and private (charts) 12
    - Devastation, deterioration, eastern softwoods 853
    - Devastation, deterioration, western softwoods 855
    - Distribution by timber size (chart) 225
    - Federal and State, in national plan 77
    - Future acquisition, by public agencies (table) 1298
    - Future management of (table) 1281
    - Future ownership of 1253, 1280
    - Indian lands (table) 611, 627
    - Influence on watersheds (chart) 28
    - Old-growth and second-growth (chart) 128
    - Present ownership (table) 1255
    - Private 134–135
    - Private ownership, basis 1256
    - Public 136–138
    - Public, for fishing 515
    - Public ownership, basis 1256, 1259
    - Public share in (chart) 78
    - Requring fire protection (table) 1396
    - State, county, and municipal 824
    - Timber production, summary 43
    - Types of management, proposed (table) 231
    - Under cooperative fire protection (chart) 105–109
    - Usable for game (table) 502
    - Watershed-protection value, ownership (table) 1286
  - Forest range (table) 528
    - Management (chart) 18
    - Program, summary 55
  - Forestry enterprise, comparative (charts) 39–40
  - Future public ownership, timber production (table) 1283
  - Harvested crops, decrease and increase (maps) 251
  - Industrial timberland (charts) 130–134
  - Industrial timberland, private ownership, future 1271
  - National-forest acquisition program (table) 575
  - National-forest lands, present and prospective (table) 1264
  - National forests:
    - By regions (table) 569
    - Total (chart) 1097
  - Necessary, national timber requirements 1280
  - Present private forest, future division, management (table) 1282
  - Private forest land used in public interest 1265

Areas—Continued Page

  - Private industrial timberland, growth classes, future (table) 1273
  - Private watershed protection, public acquisition (table) 1288
  - Productive timberland, public and private (chart) 26
  - Protected, public and private (chart) 13
  - Public, acquired to date, existing programs (tables) 1264
    - Basis division between agencies 1261
    - Closed to hunting (table) 508
    - National plan, summary 68
  - Public and private, versus expenditures (chart) 77
  - Public domain included in national forests 571
  - Recreation 485
    - Requirements, summary 53
- Area required, extensive forest management program, summary 47
  - Intensive forest management program, summary 47
- Areas, saw-timber, cordwood and restocking (chart) 134
  - 1950 (table) 227
- Area, State forests, present and prospective, (table) 1264
  - Town and municipal forests (table) 845
  - Under forest management, public and private (charts) 17
  - Under management, present and proposed (chart) 48–49
  - United States, by major uses (chart) 121
  - Watershed, feasible for public ownership 1291
    - Recommended for public ownership (table) 1293
  - Western State grant lands 840
  - Woodland on farms, future ownership (table) 1278
- Argentina, regulation of private forests 1005
- Arkansas and Red River drainages 404–411
  - (map) 359
- Arnold Arboretum 990
- Artificial reforestation research 671
- Austria, regulation of private forests 1006
- "Auxiliary forests", States providing for control of (map) 1002
- Availability:
  - Naval stores 203
  - Pulpwood 195
  - Timber stands 189

B

- Badlands, critical erosion problems 1529
  - Missouri River basin 399
- Baker, Willis M., coauthor 1587
- Balance between timber supplies and requirements 235
- Bankruptcy, private ownership breakdown 872
- Bavaria, protection forests in 1017
- Bear, on national forests (table) 493
- Beetles, bark:
  - Control 627
    - National forests 600
  - Losses from 724
- Behre, C. Edward:
  - Acknowledgement to 173
  - Coauthor 1231
- Belgium, regulation of private forests 1008
  - Wood use 286
- Biolley, H. C., example of forest management by 906
- Biological Survey, Bureau of, coauthor 1547
  - Forest research program for 1566, 1612
- Birds, forest resource 489
  - Positive values in (table) 495
- Blister rust, white pine 712, 1420
  - Campaign against 1137
  - *See also* Diseases.
- Blueberries, a forest by-product 558
- Board(s), paper:
  - Consumption (table) 259
  - Production 261
  - Pulp requirements for 261
- Boards, wall, world production 294
- Boise River watershed, erosion survey on 454
- Boxes, lumber consumption for 253

Page
Boyce, J. S., coauthor 695, 1135, 1419
Boyce Thompson Institute for Plant Research 988
Brazil, regulation of private forests in 1008
Breakdown of private forest-land ownership (section) 869
Breaks and Badlands, critical erosion problems in 1529
Breaks forests, erosion in 410
Brown-spot needle disease 696
Brush, W. D., acknowledgment to 173
Brushlands, semiarid watershed problems 1531
Budget, timber, problem of balancing, summary 22
Building, world use of wood in 294
Bulgaria, regulation of private forests 1008
Bureaus, Department of Agriculture. (*See* Bureau name.)
Burn(s), acreage versus precipitation, national forests (chart) 596
  Annual public and private land (chart) 14
  National forests versus recreation use 597
  In re run-off (chart) 319
Business administration of national forests 602

C

California drainages:
  Map 419
  Watershed conditions 420, 424
California, early attempts at development of State forestry 750
Callaghan, F. P., acknowledgment 495
Campbell, R. S., coauthor 527, 1537
"Camp-site areas" for recreation 477, 486
Canada, imports, paper, etc 265
Capacity, carrying, of western ranges 541
Capital:
  Borrowed, cost to forest industries 1129
  Credit, limitation of 1130
  Forest:
    Annual gain and loss (chart) 25
    Source of 1128
  Investment:
    All forest land, in national plan, summary 72
    And current charge increases, national forest expenditures 1314
    National forests (table) 605
Carnegie Institute of Washington, research by 987
Car, railroad, lumber consumption for 255
Carrying capacity. (*See* Capacity.)
Cascades, drainages (map) 451
Cascara bark 557
Cassidy, H. O., acknowledgment 527
Causes of fires, national forest, State, private lands (table) 1404
Cellophane, pulp requirements for 263
Central coast drainages, California, watershed conditions on 424
Central States:
  Abandoned farm lands, critical watershed problems 1524
  Agricultural land abandonment in 160
  Federal cooperation in 1072
  Forest planting needs 1503
  Forest range use in 552
  Hardwood forests, private, condition and management 957
  Opportunities for intensive forestry 1475
  State aid in 1195
Chapline, W. R., coauthor 527, 1509, 1537
Chemistry and Soils, Bureau of, research program 1566
Chemistry, wood, research 1387
Chestnut:
  Blight 711
  Blight-killed, salvage of 706
  (*See also* Forest diseases.)
Christmas greens, a forest byproduct 558
Civil service, essential to State forestry organization 816
Clapp, E. H., author 1, 651
Clarke-McNary law:
  Appropriations authorized by 1615
  Extension administration under (chart) 1083
  Forestry extension activities under 1575
  Modifications in national forestry plan 75
  National-forest development 517

Clarke-McNary law—Continued Page
  Part in cooperative fire costs 820
  Purpose of 1172
  Sections 2 and 3 1055
  Section 4, cooperation under 1076
  Section 5, cooperation under 1081
Climate, watersheds:
  South Atlantic drainages 341
  West Gulf drainages 359
Cloquet Forest Research Station 794
Colleges, agricultural, Federal cooperation with in forestry extension 1575
Colorado, early attempts at establishment of State forestry 750
Colorado River Basin 430, 437
  Map 431
Columbia River Basin drainage 430, 451, 457
  Map 451
Commercial forests, private:
  Areas and character (table) 892
  Conditions on 896
  Lake States (table) 962
Commercial forest land, ownership:
  Areas (chart) 11
  Present and proposed (chart) 69
Committees on land use 1247
Commodities, classification of 246
Community development:
  Forest exploitation and destruction 106
  Permanent forest industry on 109
Community forests 843
Composition, wood, research 1386
Conditioning for use of forest products, research in 677
Conditions of growth, research in 680
Conifers:
  Commercially important, growth and yield (table) 903
  Diseases of 696
  Pacific coast, management, sustained yield 916
  (*See also* Pine.)
Conservation:
  Fish supply 516
  Forest, development of policy 1591
  Water:
    Indian forests 623
    National forests 589
Conservation department, origin of concept of 762
Construction:
  Competition of materials in 250
  Direct-to-. (*See* Direct-to-construction.)
  Lumber use, factors affecting trends 249
  Residential 250
  Trends (chart) 252
  Urban nonresidential 249
  World use of wood in 294
Consumption:
  Crossties (table) 271
  Forest products:
    Central States 958
    Importance of increase 1356
    Lake States 962
    New England and Middle Atlantic States 968
    Pacific coast 912
    Program for extension, summary 50
    Rocky Mountain region 933
    South 940
  Lumber:
    Estimated normal (table) 256
    Hardwoods versus softwoods 257
    Manufacture of (table) 253
    Rural 249
    Tables 247, 249
    Trends 246
      Chart 247
  Naval stores 273
  Newsprint:
    Trends in 263
    Versus newspaper size (chart) 262
  Paper:
    By kinds (chart) 261
    Per capita (chart) 258
    Tables 259, 262
    World's (table) 293
  Raw materials, in paper manufacture (table) 259

Page

- Consumption—Continued
  - Timber:
    - Central, Northern, and Western Europe (table) 288
    - Commodities (table) 214–215
    - Great Britain (table) 285
  - Wood:
    - Decreasing throughout world? 283
    - Denmark (table) 286
    - European trends 283
    - Fuel 272
    - Minor products (table) 275
    - Prior to industrial era 280
    - World trends 279
- Containers:
  - Wood and fiber-board, research in 991
  - World's use of wood in 294
- Control:
  - Fire, national forests 597
  - Insect damage, national forests 600
  - Public, of private forests in other countries 1005
- Conversion trend, tree volume to mill tally (chart) 953
- Cooperation:
  - Forest products research 1391
  - With States:
    - Farm forestry extension 1081, 1576
    - Farm forest planting 1076
    - Financial aspects 1219
    - Fire protection 1054
- Cooperative fire costs, distribution (table) 819
- Coos Bay Wagon Road land grant 647
- Copeland, Senator Royal S.:
  - S.Res. 57 submitted by II
  - Resolution requesting report 81
- Cordwood:
  - Areas:
    - Industrial (chart) 134
    - Public (chart) 136
    - Woodland (chart) 135
  - Drain, annual:
    - Chart 210
    - Tables 207, 209
  - Ownership 188
  - Paper manufacture (table) 182
  - Private lands (table) 893
  - Producing areas, present and proposed (chart) 225
  - Stand, ownership (chart) 188
  - Volume (tables) 180, 181
- Costs:
  - Fire protection, cooperative (table) 819
  - Increases, future, management present national forest areas 1313
  - Indian forests 628
    - Table 629
  - Logging, versus log prices, Columbia River (chart) 924
  - Measures to prevent devastation:
    - Douglas fir type 1434
    - Hardwood types 1450
    - Larch-fir type 1438
    - Longleaf-slash pine type 1445
    - Ponderosa pine type 1443
    - Shortleaf-loblolly pine-hardwoods type 1446
    - Spruce-hemlock type 1432
    - Sugar pine-ponderosa pine type 1441
    - Western white pine type 1437
  - National forests 1305
    - Management, reasons for increase 1308
    - State, and private (chart) 20
  - National forestry plan, summary 71
  - Prevention of devastation on private lands. (*See* Expenditures.)
  - Private forest management (table) 1320
  - Private ownership, in national plan, summary 72
  - Production:
    - Influence on permanent ownership of private industrial timberland 1265
    - Versus selling value, ponderosa pine (chart) 938
  - Protection, management, national forests (table) 1306, 1307
  - Public regulation program 1351
  - Resource management, fire protection on representative national forests (table) 1307
  - State forest management 1318

Page

- Costs and returns, ownership responsibilities 1303
  - County:
    - Forests (table) 847
    - Land, forest wild life areas on 1552
    - Parks, administration, summary 484
- Cover, forest:
  - Consumption of water by 310
  - Defined 305
  - Effects of disturbing 316
  - Effect of fire on 316
  - Function in regulating stream flow 305
  - Influence:
    - On erosion 314, 416
    - On percolation 311
  - Interception of precipitation 308
  - Reduces evaporation 309
  - Retards snow melt 308
- Coville, Perkins, coauthor 1485
- Crates, lumber consumption for 254
- Credit, forest, Federal aid in organizing 1125
- Crossties:
  - Consumption (table) 271
  - Hewed, drain 217
  - Railways, steam, mileage (table) 271
- Cull, due to decay in standing saw timber (table) 702
- Current forest devastation and deterioration 851
- Cut:
  - Annual, public and private (chart) 13
  - And losses in United States timber stands (charts) 206, 212
  - Timber 210
    - Annual average (table) 207
    - Indian lands (table) 613
    - Russia 287
    - Table 211
    - Versus use and growth (chart) 238, 239
- Cutting:
  - Eastern hardwood stands (table) 862
  - Forest, sanitation 719
  - Hardwoods 1447, 1448
  - Longleaf-slash pine type 1444
  - Notice, State regulation 1346
  - Ponderosa pine type 1442
  - Practices, Indian forests 621
  - Refraining from, as an element of intensive forestry 1460
  - Selective 904, 907
    - As an element of intensive forestry 1459
  - Shortleaf-loblolly pine-hardwoods type 1446
  - Southern softwood stands and California (table) 866
  - Spruce-hemlock fog belt, relation to devastation 1432
  - State regulation 1346
  - Systems:
    - Distribution of volume in residual stands (charts) 906, 917, 922, 923, 926, 929, 934, 944, 949, 970, 972, 973, 974, 976
    - Even-aged forest (chart) 904
    - Selection forest (chart) 905
- Czechoslovakia, regulation of private forests 1010

D

- Damage, fire, on national forests 595
- Dayton, W. A., author 554
- Decay:
  - Cull in standing timber 702
  - Forest products:
    - Loss due to 708
    - Prevention of 709
  - Prevention, forest products research 1369
  - Timber losses due to 701
  - White fir, rate of increment (chart) 703
- Deer on national forests (table) 493
- Deferred grazing 539
- Delinquency. (*See* Tax reversion.)
- Demand, forest products, changing 1355
- Demmon, E. L., coauthor 1587
- Demonstration activities of U.S. Department of Agriculture 1146
- Denmark:
  - Regulation of private forests 1010
  - Wood use (table) 286
- Depleted western ranges, restoration of 539

Page

- Depletion, forest, relation of national land-use policies to 1589
- Desert basin, California, watershed conditions in 425
- Design and adoption of forest products, research in 679
- Deterioration:
  - Current forest 851
  - Eastern softwood areas 853
  - Effect of cutting, eastern hardwoods (table) 862
  - Effect of fire, hardwood stands (table) 857–858
  - Fire:
    - Effect on eastern softwoods 859
    - Effect on western softwoods 860
  - Forest, hardwood areas 852
  - Responsibility of private owner, summary 12
  - Western softwood areas 855
  - Devastated land, public and private (chart) 12
- Devastation:
  - Annual (chart) 12
  - Annual, forest land (table) 852
  - Current forest 851
  - Deterioration:
    - Effect of cutting, California and southern softwood stands (table) 866
    - Effect of cutting, eastern hardwoods (table) 862
  - Eastern softwood areas 853
  - Fire:
    - Area burned annually (table) 861
    - Effect on eastern softwoods 859
    - Effect on western softwoods 860
  - Forest, hardwood areas 852
  - Prevention program, summary 47
  - Responsibility of private owner, summary 12
  - Western softwood areas 855
  - (*See also* Forest devastation.)
- Diameter limit, cutting:
  - Realization values (table) 908
  - (*See also* Selective cutting.)
- Direct-to-construction consumption of lumber (table) 249
- Diseases:
  - Control 708, 719, 1423–1424
  - Exotics 698
  - Immature forests 699
  - Forest 46, 695, 1135, 1218, 1419, 1601, 1613
    - Agencies needed for prevention of 1422
    - Control, status of 717
    - Introduced 710
    - Need for Federal aid in control 1218
    - Protection from 1419
      - Forest Service program, proposed 1620
    - Relation to recreational use 705
    - Relation to watershed protection 705
    - Research and control, status of 717
    - State aid in control of 1182
    - Timber losses due to 701
  - Plant, introduced 710
  - State activities 718, 1135, 1218, 1422, 1427, 1428, 1601
  - Tree. (*See* Diseases, forest.)
- Disposition of tax-title lands, present provisions (examples) 885
- Distribution, forest land:
  - Future acquisition, by public agencies (table) 1298
  - Future ownership 1253, 1280
    - Public agencies 1296
  - Present ownership (table) 1255
- Donations, land:
  - Private ownership breakdown 871
  - To public 1167, 1251
- Douglas fir:
  - Management to maintain productivity 916
  - Measures to prevent devastation in 1431
    - Table 1451
  - Typical stand, western Washington (table) 920
- Drain:
  - And growth, problem of balancing, summary 23
  - Annual, saw timber and timber (chart) 24
  - Estimated, 1930–50 (table) 223, 227
  - Forest 205
    - Charts 206–211
  - Measure of requirements (table) 237
  - Relation to current growth (table) 222

Page

- Drainages:
  - United States (maps) 331, 332, 341, 351, 359, 371, 379, 396, 419, 431, 445, 451
  - (*See also* Northeastern, South Atlantic, East Gulf, West Gulf, St. Lawrence River, Hudson Bay, upper Mississippi River, Ohio River, Missouri River, Arkansas and Red River, lower Mississippi River, California, Colorado River, upper Rio Grande, Great Basin, Columbia River, Pacific Cascade.)
- Duke University, forest research by 987
- Dunes:
  - Coastal, critical watershed situation 1525
  - Formation and control 316
  - Northeastern coast 336
  - South Atlantic coast 345
- Dutch elm disease 714

E

- East Gulf drainages (map) 351, 355
- Eastern forests, measures to prevent devastation in 1444
  - Table 1451
- Eastern States, development of national forests in 1171
- Eastern United States, agricultural land abandonment in 152, 164
- Eberly, H. J., author 1177, 1224
- Economic benefits, full realization of, a major forestry objective 41
- Economic effect private ownership on forest industries, summary 15
- Economic values of wild life 490, 494
- Economics, forest:
  - Federal research in, as a form of State aid 1142
  - Forest Service research program, proposed 1618
  - Research in 681, 1562
- Economics, public ownership, forest land 1257, 1259
- Education:
  - Expenditure (chart) 20
  - Fire prevention, State 818
  - Forestry 785–786
    - State function 784
  - In forest wild life 1554
  - Need in fire-control program 1405
  - Vocational, as aid to forestry 1093
- Eldredge, I. F., coauthor 1575, 1587
- Elk, on national forests (table) 493
- El Salvador, regulation of private forests 1011
- Employment:
  - Emergency, forests as a source of 105
  - In forest industries 96, 102
  - Under sustained-yield forestry:
    - In Europe 103
    - In the United States 104
- Enlarging the consumption of forest products (section) 1355
- Entomology:
  - Bureau of, author 1415
    - Activities and expenditures 1139
    - Federal research in, as aid to States 1139
    - Forest insect work of 723
    - Forest research program for 1565, 1614
    - Preventive aspect 729
    - Progress in 723
    - Research, private and quasi-public 985
    - Research, program for 1565
    - Research, by States 1140
- Equipment, fire-control organizations 1407
  - State fire protection 818
- Erosion:
  - Arkansas and Red River drainages 404, 408–409
  - Breaks forests 410
  - Burned areas, southeastern California 425
  - Colorado River Basin 433
  - Columbia River drainage 454
  - Control, need for Federal aid in 1206
    - Program for 1509
  - Description of 304
  - East Gulf drainages 351, 355
  - Effect of fire on 316
  - Effect of logging on 321
  - Forest planting for control of 1488
  - Great Basin 449

Page
Erosion—Continued
  Hudson Bay drainage 368
  Illinois, counties affected (map) 375
  Influence of forest cover on 314
  Mississippi River Basin:
    Lower 402, 414
    Upper 372
  Northeastern drainages 335
  Ohio River Basin 384, 387
  Overgrazed forest ranges 323
  Piedmont Plateau 356, 357
  Plots protected by litter (table) 315
  Problems, magnitude of 300
    On semiarid woodlands and brushlands 1531
    Critical, Appalachian Mountains 1527
    Critical breaks and badlands 1529
    Central States abandoned farm lands 1524
    Coastal dunes 1525
    Mississippi bluff lands and silt loam uplands 1521
    Piedmont and upper coastal plains 1523
  Resulting from agriculture 326
  Resulting from improper agriculture 1522, 1523
  Resulting from smelter fumes 325, 423
  Rio Grande Basin, Upper 439
  San Joaquin River Basin 421
  South Atlantic drainages 342
  South Atlantic region, control measures 348
  Stream flow, forest and range influences—research 675
    Forest research by Forest Service 1563
  Survey in Boise River watershed 454
  West Gulf drainages 361
  Western ranges 535
  Wind 316
  Yazoo River watershed 416–417
  (*See also* Watersheds.)
Europe:
  Employment in forestry and forest industries in 103
  Forest planting in 1496
  Proportion of forest land publicly owned 139
  Timber consumption (table) 288
Evans, C. F., acknowledgment 1303
  Coauthor 1395
Evans, R. M., author 851
Evaporation, from forest vegetation 310
  Reduced by forest cover 309
Even-aged forest (chart) 904
Exchange, land, acts authorizing (table) 1163
  Cases (table) 1171
Exotics, disease situation resulting from use of 698
Expenditures, additional needed in national plan, summarized 75
  All forest activities, 1932, summary 70
  Cooperative fire protection (charts) 1061, 1067
  Federal insect control 1139
  Federal, on navigation facilities (table) 303
    And State, proposed for 1935–39 (table) 1340
  Fire control, national forests, ultimate (table) 1409
    Present and needed, State and private lands (table) 1270
  Fire protection (tables) 1408
    Cooperative (table) 819
    Distribution (table) 1063
    Program, summary 44
  Forest activities (chart) 20
  Forest disease protection program, summary 46
  Forest insect protection, program, summary 46
  Forest-planting, estimated 1508
  Forest research (table) 1557
    Prospective 690
    By private and quasi-public agencies 1571
    State 1603
  Forest Service research, needed 1618
  Forestry extension 1576, 1577
    Proposed 1584, 1585, 1586
  Forestry program, estimated (tables) 1628
    Federal bureaus 1609
      Financing of 1632
  Forestry, public and private (chart) 10
    Public and private versus area (chart) 77
  Increases needed, management present national forests 1314

Page
Expenditures, indian forests (table) 628, 629
  Insect control 1417
  Management, and protection, new national forest units (table) 1316, 1318
  National forest, involved in proposed Forest Service program 1622
    Segregation of capital-investment and current-charge increases 1314
  National forestry plan, all agencies 70
  Needed, fire control national forests—State—private land (and tables) 1409, 1410
    To prevent devastation on private lands 1451
  Planting program, summary 50
  Public, regulation, protection forests 1351
  And receipts, national forests (table) 605
  Recreation, national 468
  Research, Forest Service 1143
  State aid (tables) 1178, 1179
  State and Federal aid, 20-year program (table) 1341
  State, forest acquisition, suggested 1604
    Involved in forestry program 1607
  State forests management 1318
  Stopping forest devastation, summary 47
Experiment stations, Federal forest 1141
Experimental forests, forest-school 986
Exploitation, forest, detrimental effects of 993
Exports:
  Lumber, all countries post-war (table) 291
    United States (table) 247
  Wood, world trends in (tables) 290
Extension:
  Expenditures (chart) 20
  Farm forestry, administration 1083
    Expenditures (table) 1082
    Federal aid to States 1081
    Methods 1086
    Organization for expansion of 1583
    Results of cooperation in 1084
    Statistical results (table) 1085
  Federal aid 1337
  Forestry, activities, Federal and State 1576
    Additional Federal organization proposed 1585
    Appraisal and program 1575
    Benefits to private owners 787
    Industrial, organization for 1584
    Methods 784
    State activity 786
    State aid to private owners 1181
    Ten-year program 1581
  Noncommensurate with forest research, summary 35
Extensive forestry:
  Definition 230
  Estimated growth on areas allocated to (table) 232
    Growth under (chart) 233
    Three management plans (table) 242
Extensive management, forest land, areas (chart) 48

F

Factors affecting Federal and State aid (section) 1203
Factory consumption of lumber (table) 249
Factory products, lumber consumption in 253
Farm, a diminishing market for lumber 249
Farm forestry extension. (*See* Extension.)
Farm forests, Federal aid in establishment 1212
Farm land(s):
  Abandoned, future ownership 1275
  Abandonment of, lower Mississippi River Basin 414
  Marginal, Ohio River Basin 393
  Watershed conditions on Ohio River Basin 391
Farm woodland(s):
  Conditions in 897
  Desirability of planting 1491
  Managenemt, Central States 959
  Owners' forestry extension needs 1581
  Products, quantity and value 897
  (*See also* Woodlands; Ownership, private.)

Page
Farm(s):
  Abandoned, available for forestry 151
  Abandonment, problems of 167
  Areas in, formerly forested (table) 154
  Decrease in area of (charts) 156–157
Farmers, trees distributed to (table) 1078
Federal:
  Aid in organizing forest credit facilities (section) 1125
    Extension 1337
    Planting 1336
    20-year program (tables) 1340–1341
    Summary of 4
    (*See also* Aid, Federal.)
  Contribution to progress of forestry 2
  Forest acquisition program (table) 575
  Forest land used by game 506
  Forest research program, summary 55
  Grant lands, unreserved (table) 826
  Land, wild life areas on 1552
  Land bank system, relation of forest loans to aims of 1132
  Legislation required in national plan 75
  Responsibility, public regulation 1344
    Regulation scope 1347
      Share in fire costs (table) 819
      Share in forestry expenditures (chart) 10
Federal Government responsibility for forestry 1609
Federal-State aid, protection, insects 1336
Federal regulation, protection forests 1351
Fiber, processing, research 1384
Fiber-producing plants, a forest byproduct 560
Field units of research—most effective 656
Finances, for research 663
Financial program, fire control, national forests, parks, Indian lands, public domain 1412, 1413, 1414
Financing current and capital costs in national plan 74
Financing fire-control program 1405
Financing Indian forest work (table) 628, 629
Financing of private forestry 1125, 1129
Financing of national forestry plan, summary 71
Finland, regulation of private forests 1011
Fire:
  Area and cost, Indian forests (table) 627
Fire control:
  Costs national forests (table) 1409
  Expenditures 1407
    Present and needed, State and private lands (table) 1270
  Financial program, national forests, parks, Indian lands, public domain 1412, 1413, 1414
  Needed expenditures, national forests, State and private land (tables) 1409–1410
  Organization, functions and equipment 1405
  Program needs 1403
Fire(s):
  Damage to watershed values, Columbia River Basin 456
  Indian forests (table) 627
  Devastation, area burned annually (table) 861
  Effect on eastern softwoods 859
  Effect on floods 316–320
  Effects of, in fringe forest type of Arkansas and Red River drainages 409
  Effect on hardwoods 857
  Effect on run-off, Ozark-Ouachita forests 409
  Effect on western softwoods 860
  Effect on run-off and erosion 316
  Excessive run-off following, southern California 427
  Expenditures (chart) 20
    National forests (table) 605
  Forest, in Massachusetts and Pennsylvania 1921–31 (table) 808
    Prevention stressed by States 806
    On protected areas 1067
    On protected areas, 1926–30 (table) 1068
    Protection from. (*See* Protection, forest fire.)
    On unprotected areas, 1926–30 (table) 1068
  Laws, needed 1405
  Losses, annual 207, 218
  Number and causes (table) 1396, 1404
  Ohio River Basin 390
  Precipitation versus acreage burned, national forests (chart) 596
  In re precipitation and run-off (chart) 319

Page
Fire protection:
  Adequacy on national forests (chart) 599
  Cooperation, expenditures (charts) 1061, 1067
  Areas involved (chart) 1059
  Expenditures, State, private land (tables) 1408
  Indian forests 626
  National forests 595
  National forests versus recreation (chart) 597
  National parks 635
  Needed and given (chart) 13
  Needed for correction of watershed conditions:
    Ozark-Ouachita area 1527
    Pacific slope dense forests 1529
    Private land, needed to prevent devastation (table) 1451
    Program, summary 44
    Progress and requirements of research 672
  Public domain 641
  Simple, defined 230
  State organization needed 818
  States providing for regulation (map) 1000
  State and private, progress in (chart) 1059, 1061
Fires:
  Speed of attack 1405
  Timber killed by (table) 218
  Use of by landowners 1210
Fire weather research by Weather Bureau 1568
Fish hatcheries in national parks 522
Fish, in national forests 595
  Positive forest values in (table) 495
  Resource, conservation and upbuilding 516
Fish life, influence of forests on 511
Fish, in streams on western forest range 538
Fisheries, Bureau of, forestry program, proposed 1611
  Forestry research program for 1567
Fishery, program of management 515–519
  Management in forest waters 510
  Research in forest waters, by Bureau of Fisheries 1567
  Research required 523
Fishing, public areas for 515
Flood control, need of Federal aid in 1206
Flood problems, critical:
  Central States 1524
  Mississippi River bluff lands and silt loam uplands 1521
  Piedmont and upper coastal plains 1523
Floods, disastrous, summary of (table) 304
  Effects of overgrazing on 535
  Arkansas and Red River drainages 404
  Colorado River Basin 435
  Columbia River Basin 455
  From burned areas, southern California 427
  Great Basin 447
  In lower Mississippi River Basin 413
  In Yazoo Delta 413
  Increased by fire 316
  Mississippi River, magnitude of 303
  Missouri River Basin:
    Lower 400
    Upper 397
  Northeastern drainages 336
  Ohio River Basin 381
  Pacific Cascade drainages 458
  South Atlantic drainages 346
  West Gulf drainages 360
  Yazoo River, measurements of run-off and erosion in 416
Forage. (*See also* Grazing, Overgrazing, Range.)
  A major forest resource 144
Forage crops on southern range 551
Forage, an important forest land resource 527
Forage production, in eastern States 552
  In the South 547
  Western forest range 530
Forage, selection and hybridization of 540
Forage use on national forests 586
Forest activities, public and private share (chart) 19
  Total expenditures (chart) 20
Forest areas, commercial (chart) 127
  Old-growth and second-growth (chart) 128
Forest capital, annual gain and loss (chart) 25
Forests, classified by watershed influence 329
  Commercial, area of (table) 126
    Classification of 128
    Distribution of 126
  Community 843

Page
Forest cover. (*See* Cover, forest.)
  Effectiveness in controlling run-off 1522
  Influence in controlling run-off and erosion, Southern California 426
  Influence in regulating stream flow, study in Clearwater River drainage 453
  Watershed protective value. (*See* Run-off, erosion.)
Forest, dependence of wild life on, summary 30
Forest devastation, agencies responsible for 1429
  Definition 1429
  Hardwoods, measures to prevent in 1447
  How to stop (section) 1429
  Measures to prevent in larch fir type 1437
    Lodge-pole pine type 1443
    Longleaf-slash pine type 1444
  Measures needed to prevent in eastern forests 1444
    Western forests 1430
    Sugar pine-ponderosa pine type 1439
    Ponderosa pine type 1441
    Private land (table) 1451
  Expenditures needed to prevent, private lands 1451
  Measures to prevent in, redwood type 1443
    Shortleaf-loblolly pine-hardwoods type 1445
    Softwoods 1446
    Spruce fir type 1443
    Western-larch-western white pine type 1435
Forest diseases, preservation of recreation areas 481
  State control efforts 821
  National forests 601
  Protection program, summary 46
  Regulations for control of 1001
Forest drain. (*See* Drain.)
Forests, economic importance of 96
Forest economics, research in 681
Forest fire. (*See* Fire.)
Forest fire protection, progress and requirements of research 672
Forests:
  Foreign, public control of 1005
  Habitat of wild life 95
  Indian. (*See* Indian forests.)
  Industrial, owners' and managers' forestry extension needs 1582
Forest industries:
  A plan for perpetuating 1588
  Dependent on solution of forest problems, summary 36
  Difficulties, private owner's responsibility for, summary 15
  Migration of 192
Forests:
  Influence on fish life 511
  Influence on watersheds, zones of (maps) 332, 341, 351, 359, 371, 379, 396, 419, 431, 445, 451
Forest insects:
  Beneficial 731
  Activities and control 723–729
  Cooperation in efforts to control 728
  Indian forests 627
  Interrelation with fungi 731
  On national forests 600
  Preservation of recreation areas 481
  Protection program, summary 46
  State-control efforts 821
Forest land(s):
  Acquisition, Weeks law 1171
    Cost public program 1299
  Acquisition, cost 1299
  Administration, State 823, 832
  Annual burn (table) 1396
  Area(s) devastated annually (table) 852
    For full use of timber production, summary 43
    Future public ownership (table) 1283
    Private, used in public interest 1265
  Balancing uses 1238
  Barren and unproductive 1485
    Reforestation program for 1498
  Burned over, public and private (chart) 14
  Classification, proposed by Forest Service 1564
  Closed to hunting (table) 508
  Commercial and noncommercial, ownership, present and proposed (chart) 69
  Cut over annually (chart) 13
Forest land(s)—Continued Page
  Devastated, public and private (chart) 12
  Federal acquisition of, by exchange 1163, 1250
    By purchase 1165, 1248
    Methods 1162
    Program (table) 1173
  Federal purchases of (by fiscal years) 1165
  Forest wild-life management unification 1548
  Future acquisition, public agencies (table) 1298
  Future management areas (table) 1281
  Future ownership 1253, 1280
  Indian, allotment policy 614
    Areas (table) 612
    Grazing on 621
  Industrial, area (charts) 130–134
  Influence on watersheds (chart) 28
  Management, plan for, to meet requirements 241
    Plans for full use of 242
    Relative financial capacity, State groups (table) 1297
  National cost of management, reasons for increase 1308
  Needed for range and livestock 1235
    Recreation 1234
    Timber production 1235
    Watershed protection 1234
    Wild life 1235
  Needed to meet timber requirements, summary 44
  Objectives in use of 1233
  Ownership (chart) 11
    Anticipated shifts in 1242
    Future distribution public agencies 1296
    Present and planned (chart) 52
    Present (table) 1255
    Responsibilities, costs, and returns 1303
  Present private, future division, management (table) 1282
  Private, basis for ownership 1256
    Areas in national plan, summary 59
    Management costs (table) 1320
    (*See also* Tax delinquency.)
    Ownership situation 869
    Public acquisition, watershed protection (table) 1293
    Public control in other countries 1005
    To public, factors that deter 884
    Visitors to (table) 465
    Watershed protection values conserved 1287
  Privately owned, public regulation of 993
  Problem of private ownership, summary 11
  Productivity, a major forestry objective 41
  Program of fishery management 519
  Public acquisition justified 1150
  Public, acquisition, progress to date, existing programs (tables) 1264
    Acquisition by donation 1167, 1251
    Basis division between agencies 1261
    Basis for ownership 1256, 1259
    Desirability of State ownership 1262
    Multiple use 1294
  Purposes of public acquisition of 1158
  Recommended for public ownership for watershed protection (table) 1293
  Regulation of use of, as remedy for exploitation 994
  Resource, capital value, summary 73
  Restrictions on use of fire by owners of 998
  State acquisition by purchase 1249
  Tax delinquent 1250
  Tax delinquency and reversion (*See* Tax) 887
  Tax reversion future trends 887
  Tax reverted, problems of, summary 21
  Total areas, available 1231
  Use, anticipated shifts in 1242
  Use by game 506
  Watershed protection, public ownership feasible 1291
    Value, ownership (table) 1286
  Wild life dependent on 489
    Population, values of 492, 494
Forests, livestock ranges 95
  Local public, income 1326
Forest loans, amortization rates 1132
  Organization of 1132
Forest management, blocking up of private areas for 900
  Central States hardwoods 957

Page

- Forest management—Continued
  - Cutting and silvicultural system, 904
  - Even-aged forest (chart), 904
  - Extensive, areas (chart), 48
    - Program, summary, 47
  - Farm woodlands, Central States, 959
  - Intensive, forest areas (chart), 49
    - Program, summary, 49
  - Multiple-purpose, defined, 89
  - Naval-stores production, 955
  - Practices, regional, 911
  - Other classes research, 673
  - Private, Lake States, 961
    - Measures for improving, 978
    - New England and Middle Atlantic States, 966
    - Pacific coast, 911, 916
    - Rocky Mountain region, 931–7
    - Separation from manufacturing desirable, 981
    - South, 939
    - Single-purpose, place of, 90
    - Summary, 16
  - Progress and requirements of research, 669
  - Public and private (charts), 17
  - Research by Forest Service, 1557
  - State, costs, 1605
  - Southern properties, 953
  - Selection forest (chart), 905
  - (*See also* Intensive forestry, Liquidation policy.)
- Forest mensuration, progress and requirements of research, 671
- Forests, national. (*See* National forests.)
- Forests as natural laboratories for research, 560
- Forest pathology. (*See* Diseases, forest.)
  - Diseases, in national forests, 601
- Forests, permanent, as basis of community development, 108
- Forest policy, Indian, 620
- Forest practice, distribution of volume in various cutting systems (charts), 906, 917, 922, 923, 926, 929, 934, 944, 949, 970, 972, 973, 974, 976.
- Forests, private, income (table), 1323
  - Public control of, in other countries, 1005
- Forest problems, solution constitutes national problem, 35
  - Summary, 11
- Forest products. (*See also* Products.)
  - Central States, 958
  - Changing demand, 1355
  - Classification of, 246
  - Construction material, competition with, 251
  - Consumed in agriculture, 97
  - Decay, prevention of, 709
  - Demand for, 899
  - Farm, value of, 98
  - Farm woodland, quantity and value, 897
  - Federal research in as a form of State aid, 1143
  - Fungous injury to, 707
  - Importance increasing of consumption, 1356
  - Improvement of production, 1362
  - Industrial organization and practice, 1358
  - Insect damage to, 726
  - Integration of industries, 1360
  - Lake States, 962
  - Loss from decay, 708
  - Merchandising, 1364
  - Minor, wood consumption in (table), 275
  - Miscellaneous, 554
  - New England and Middle Atlantic States, 968
  - Pacific coast, 912
  - Production and consumption:
    - Central States, 958
    - Lake States, 962
    - New England and Middle Atlantic States, 968
    - Pacific coast, 912
    - Rocky Mountain region (table), 932
    - South, 940
- Forest products research, 676, 1365
  - Better unit construction, 1367
  - Better use of wood, 1367
  - Conversion, 1376
  - Design of fabricated products, 1371
  - Engineering resources, 1367
  - Form of product, 1372

Page

- Forest products research—Continued
  - Fiber processing, 1384
  - Fire retardants, 1369
  - Fundamental and utilization, 1391
  - Gluing, 1371
  - Log grading, 1377
  - Logging equipment, methods, 1378
  - Markets, expansion, proposed action, 1357
  - Mechanical, physical properties, 1388
  - Mill waste utilization, prevention, 1385
  - More marketable products, lower costs, 1372
  - Naval stores harvesting, 1379
  - New pulping processes, 1381
  - Painting and moisture proofing, 1370
  - Paper machine operating, 1385
  - Prevention of decay, 1369
  - Production improvement, 1362
  - Pulp and paper, 1379
  - Pulping processes, improvement, 1381
  - Pulping new species, 1382
  - Rocky Mountain region, 932
  - Seasoning, 1374
  - Selection and grading, 1373
  - Selective logging, 1378
  - Selective logging, sustained yield, 1360
  - Shrinkage, prevention, 1369
  - South, 940
  - Timber-growth conditions, 1389
  - Transportation, 1358
  - Uses, coordination, 898
  - Users' forestry extension needs, 1582
  - Utilization, improved, as an element of intensive forestry, 1463
  - Wood chemistry, 1387
  - Wood-destroying organisms, 1390
  - Wood structure, 1386
  - Wood structure, composition, properties, 1386
- Forest Products Laboratory, 1143
- Forest production:
  - Financing of, 1125
  - Public returns from, 111
  - Small-timber holdings, 1361
- Forest properties:
  - Economic size, 900
  - Organizing, 901
  - Investments involved in building up, 1127
- Forests, protection, Federal regulation, 1351
  - Classification, 1347
- Forests, protection, in foreign countries, 1005, 1035
- Forests, public, income possible (table), 1322
  - Watershed protection, limiting factors, 1288
- Forest ranges, 527
  - Areas, public share of (chart), 78
  - Eastern United States, forage production, 552
  - Improvements, 543
  - Indian reservations, 546
  - Influences, research, erosion, and stream flow, 675
  - Investigations, research, 673
  - Management problems, western, 535
  - On national forests, 544
  - Ownership (table), 528
  - Ownership, western, 544
  - Problems, southern, 550
  - Problems of, summary, 32
  - Program, summary, 55
  - On public domain, 546
  - In the South, 547
  - Management program, 1537
  - Research program, suggestions regarding, 1540
  - Use and revegetation, 539
  - Western, conditions of, 532
    - Carrying capacity, 541
    - Livestock, distribution on, 542
    - In private ownership, 547
    - Seasonal use, 542
    - In State ownership, 546
    - Extent and importance, 528
    - Forage production, 530
- Forest for recreation, 463
  - Regulation. (*See* Regulation, public.)
  - Recreationists (table), 465
- Forest (s):
  - Regions of United States (map), 123
  - Relation to watershed problems West Gulf drainages, 363
  - Watershed protection, summary, 27

Page
Forest research, agencies conducting projects in New England and New York (table), 792
    Appropriations (chart), 1144
    Artificial reforestation, progress and requirements, 671
    Branch of, establishment, 651
    By products, 561
    State agricultural experiment stations, 796
    States, pathological, 718
      Scope of, 791
    Conditioning forest products, 677
    Design and adaptation of forest products, 679
    Development of, 788
    Development of organization and facilities, 655
    Economics, 681
    Endowed research institutions, 987
    Entomological, 728
    Enlarging consumption of forest products, summary, 51
    Expenditures (chart), 20
    Federal activities in, 791
    Finances for, 663
    Financial needs, 690
  Fishery, required in management, 523
  Forest fire protection, 672
    Management, other classes, 673
      Progress and requirements in research, 669
    Products, 676
  Forest and range influences, erosion—stream flow, 675
  Forest range investigations, 673
  Forest Service, history, 651
  Forest survey, by Forest Service, 1560
  Gains in efficiency after segregation of division, 653
  In Forest Service, objectives, 651
  In grading and selection of forest products, 677
  In growth conditions, 680
  Industrial, 990
  Mensuration, progress and requirements, 671
  Methods of harvesting forest products, 676
  Modifications of McSweeney-McNary Act needed in national plan, 75
    Of properties of forest products, 678
  Most effective field units, 656
    Satisfactory working facilities, 661
  National and State aspects, 791
  Natural reforestation, progress and requirements of research, 670
  Need for cooperation in demonstrating results, 980
    For extension, summary, 33
  Objectives, past, present, and future, 682
  Pathological, 717
  Participation of States in initiation of, 790
  Personnel, 665
  Private, expenditures for, 992
    And quasi-public, 985
Products. *See* Forest products research.
  Program as applied to entomology, 1417
    Federal, State, and private, summary, 55
  Progress made and still required, 669
  Projects in New England and New York, 1932 (table), 792
  In properties of forest products, 679
  Pulp and paper, private and quasi-public, 990
  Relationship with administration, 655
  State activities, scope of, 793
    Expenditures for, 797
    Facilities for, 794
  Summary, 5
  Supervision required, 668
  Training of personnel, 665
  Tropical, private and quasi-public, 986, 988, 990
  Resource, wild life, 489
    Range, 527
  Resources, wild life, 505
  Schools, research by, endowed, 985
    State, research facilities, 795
Forests, service to agriculture, 97
Forest Service, acquisition program, 574
  Expenditures in acquisition program, summary, 70
  Forest administration and management program, proposed, 1618
  Planting, forest acreage and survival, 1497
    Program, 1506
    Research, results, 1495

Page
Forest Service, Progress of national forests, 565
  Program, proposed, acquisition, national forest, 1618
    Cooperative, 1615
    Research, 1617
  Research, 651, 1140
    Section, 1140
    Organization, 1141
    Expenditures, 1143
Forests, State-owned, program for, 1603
  Source of recreation, 93
    Emergency employment, 105
    Wood, 91
  State. (*See* State forests.)
Forest survey by Forest Service, 1560
  Tree diseases, Indian forests, 627
    National forests, 601
  Types, western, forage produced in, 530
    Of United States (map), 123
  Use, financial aspects of, South, 941
Forests, value of for conservation of water and soil, 92
  Watershed-protective function, 305
Forest waters, fishery management in, 510
  Wild life, 489
    Areas, 1551
    Forest land management unification, 1548
    Management, 1547
Forester, letter of transmittal from, x
Foresters, extension, functions of, 787
  Extension, present and suggested numbers of (table), 1584, 1585
  State, methods of appointment of, 778
Forestry, activity programs in national plan, summary, 42
  Agency programs in national plan, summary, 57
Forestry branch, Indian Service. (*See* Indian Forest Service.)
Forestry, contribution of national forests, 565
  Definition of, 88
  Departments, State, fire protection major activity of State, organization and methods in fire protection, 805
    Personnel, selection of, 807
    Research activities, scope, 793
    Research facilities of, 794
    Results of protection efforts, 807
  Enterprise, compartive areas (charts), 39–40
    Public share in (chart), 78
  Expenditures, public and private (chart), 10
  Extension. (*See also* Extension, forestry.)
    Administration (chart), 1083
  And farming, in Great Britain, 99
  Federal, beginnings of, 1876–91, 746
    Contribution to progress, 2
    Program, proposed, 1610
  As a form of land use, 115
  Federal program, proposed financing of, 1632
  Indian reservations, 607
  Intensive and extensive defined, 230
  Justification of measured by public interest, 116
  Lands available, proposed distribution (chart), 1232
  Land available for, agricultural, 151
  Policies, "conservation department" idea, 762
    Development of in Pennsylvania, 763
    Fire protection, development of, 764
    New England States, 734
    Southern States, 739
    State:
      Diversity of, 733, 737
      Effect of Federal cooperation on, 734, 740
      Origin and development of, 742
    Western States, 740
  Private, aided by public acquisition, 1147
    Encouragement of as State function, 783
    Income, 1327
    Investment in, 1125
    Local opportunities, effect on permanent ownership, 1267
    Problems of, 85, 130
    Promotion of, 783
  Problem of adequate knowledge of, summary, 33
  Program, Federal legislation needed for, 1631
    State, proposed financing of, 1634
    Summarized as to responsibility, 1587

Page
Forestry, Progress of in United States, summary 1
  Public, misconception of in nineteenth century 745
    Need for 743
    Problems of 86
    Returns from 111
  Relation to recreation 484
  Responsibility for 1592
  Responsibility for:
    Federal Government 1609
    State and local governments 1599
  State, analysis of organizations 779
    Development of, 1885–1911 766
    Development, in New York 753
    Development in Pennsylvania 763
    Diverse policies in 733
    Early attempts at establishment 749
    Factors affecting 1225
    Factors in development of 742
    History of 742
    National importance of 1205
    Obstacles to establishment of 750
    Organization of departments of 778
    Organizations analyzed (table) 779
    Origins of 749
    Present status 778
    Reasons for Federal interest in 1205
    Status of in 1911 776
  Unproductive areas available for 1485
France, regulation of private forests 1012
  Landes region, planting results in 1496
  Wood use 287
Fringe forest, of Arkansas and Red River drainages, conditions in 409
Frothingham, E. H., author 985, 1140, 1555
Fuel wood, drain 216
  Consumption 272
Furniture, lumber consumption for 255
Fur, wild life values in (table) 495
Future adjustments in land use and ownership (section) 1241
Fungi, injury to forest products 707
  Injury to forests by 695
  Interrelation with insects 731

G

Game, big, national-forest population (table) 493
  Commissions 1553
  In re western range use 538
  Management, areas for (table) 502
  National forests 593
  Refuges, State 830
  Use of forest land for 143, 506
  (*See also* Wild life.)
Genetics, Institute of Forest 988
  (*See also* Seed, source of.)
Germany, regulation of private forests 1015
  Wood use 285
  (*See also* Europe.)
Gibbons, W. H., coauthor 121, 173
Gipsy moth, State aid in control of 1182
Girdling, as an element of intensive forestry 1456
  Hardwoods 1449
Gluing, forest products research 1371
Goats, mountain, on national forests (table) 493
Grading, forest products, research 1373
  Log, research 1377
Grading and selection of forest products, research in 677
Granger, C. M., author 565
Grants, land. (*See* Land grants.)
Grazing, by hogs, longleaf-slash pine type 1445
  Central, Lake, Middle Atlantic, and New England States 552
  Cost of management on national forests 1311
  Effect on watershed values, California 429
  Forest ranges 144, 527
  Hardwood types 1448, 1450
  In re other forest resources on western lands 535
  In re wild-life management 498
  National forests 586
    Returns 1324
  Ohio River Basin 390

Page
Grazing, Ponderosa pine type relation to devastation 1442
  Regulation for watershed protection, upper Rio Grande Basin 443
  Southern forest land, problems of 550
Grazing management, Forest Service program, proposed 1621
Grazing methods, deferred and rotation 539
Grazing problems, Central and Eastern States 553
Great Basin (map) 445
  watersheds 444, 449
Great Britain, timber consumption (table) 285
  Timber imports (table) 284
  Wood use 283
Greece, regulation of private forests 1022
Grøn, Prof. A. H., acknowledgment to 286
Growing stock, deficiencies, summary 24
  Eastern, present required (chart) 25
  Present condition 1279
  Preservation of, vital 1278
  Required to meet timber requirements (table) 233
Growth, commercial areas (table) 221
  Commercially important conifers (table) 903
  Estimated, 1950 (tables) 223, 227
    Under different types of management (table) 232
  Forest, present versus future (chart) 233
  National timber budget, summary 23
  Relation to drain (table) 222
  Timber 220
    Versus use and cut (chart) 238–239
Growth conditions:
  Timber, forest products research 1389
  Research in 680
Growth and drain, saw timber and all (chart) 24
Guatemala, regulation of private forests 1022
Gullying, upper Mississippi River basis 375
  (*See also* Erosion.)
Gum and lacquer producing plants 560

H

Hallauer, F. S., author 245
Hardwoods, Central States, conditions and management 957
  Cordwood stand (tables) 181
  Cut and destroyed annually (table) 207
  Measures to prevent devastation in 1447
  Northern, all-aged stands in White Mountains (table) 970
  Oak, well-stocked stand, Mont Alto State Forest (table) 974
  Practices to prevent devastation in (table) 1452
  Production (table) 247
  Requirements 257
  Saw timber, eastern and western, total stand (table) 179
    Present and proposed stands (chart) 226
  Saw-timber stand, United States (charts) 174–177
  Southern bottomland (table) 951
  Stand, all timber 184
    Table 176
  Used for paper, stand (table) 182
Hartley, Carl, coauthor 695, 1135, 1419
Harvard Forest, intensive forestry on 1473
  Research 985
Harvesting methods, forest products, research in 676
Hastings, A. B., author 1053, 1145
Heintzleman, B. F., author 1641
Hemlock bark for tanning 555
Hendrickson, C. I., author 151
Heredity, forest tree. (*See* Seed, source of.)
Hiking on forest "outing areas" 479
Hogs on southern range 551
Holly 559
Honey plants, forest by product 560
Huckleberries, forest by product 558
Hudson Bay drainage, stream-flow and erosion conditions 368
  Map 396
Humus, contained in forest soil 311
Hungary, regulation of private forests 1022

Page

- Hunters, wild-life values in re (table) 495
- Hunting, forest land closed to (table) 508
- Hunting grounds, public, need of 1550
  - Requirements, summary 54

I

- Idaho, tax delinquency (table) 875
- Illinois, erosion (map) 375
- Imports:
  - Lumber, 1809–1931 (table) 247
  - Paper, etc., pulpwood equivalents (table) 265
  - Relation to pulpwood requirements 264
  - Timber, relation to requirements 237
  - Versus requirements (chart) 267–269
  - Wood, pulp, and paper, in terms of wage earners (chart) 270
- Improvements:
  - Cost, on national forests 1313
  - Forest, expenditure (chart) 20
- Incendiarism on national forests 595
- Income:
  - Federal forest, prospective 1635, 1636
  - Managed forest lands 1320
  - National forests 1323
    - (Table) 605
    - Contributed to States 1326
    - Grazing 1324
    - Possible gross 1325
    - New sources 1324
    - Recreation 1324
  - Private forestry 1327
  - Private forests (table) 1323
  - Public forests, possible gross (table) 1322
  - State and local forests 1326
  - State-forest, prospective 1636, 1638
  - Timber, due to growth (table) 909
- Indian:
  - Affairs, Bureau of:
    - Forestry in 607
    - Forestry program, proposed 1612
  - Forests 607
    - Areas (table) 611
    - Costs (table) 628, 629
    - Fire area and cost (table) 627
    - Fire control, financial program 1414
    - Fire protection 626
    - Grazing administration 621
  - Land and allotment policy 614
    - Management 614
    - Personnel 628
    - Policy, general 620
    - Program, proposed, legislation needed for 1632
    - Progress in forestry 4
    - Recreation 624
    - Roads, trails, etc. (table) 626
    - Sawmill operation 624
    - Watershed protection 623, 1519
  - Reservations, forest range on 546
- Industrial forest research, program, summary 57
- Industries:
  - Commercial forest lands owned by 130
  - Forest research by 990
  - Forest:
    - Communities permanently sustained by 109
    - Economic importance of 96
    - Employment in 96, 102
  - Forest products, integration of 1360
- Influences, forest, watershed and related 299
- Information, forestry, diffusion of 1145
- Informational activities 1145
- Insects, forest:
  - Aid in control of 1182
  - Control of, Federal activities and expenditures 1139
    - Policy, National Park Service 1416
  - Losses from 1139
  - Need for Federal aid in control research 1216
  - Protection against, Forest Service program, proposed 1620
    - (*See also* Entomology, forest insects.)
- Institute:
  - Of Forest Genetics 988
  - Of forest research recommended 1573
- Institutions, quasi-public, responsibility for forestry 1598
- Intensive forestry, a program for 1455
  - Areas allocated to (table) 232
  - Areas suggested for 1468

Page

- Intensive forestry, definition 230
  - Estimated growth on areas allocated to (table) 232
  - Examples of 1473, 1474
  - Growth under (chart) 233
  - Improved utilization 1463
  - Management plans (table) 242
  - Need for 1465
  - Objectives 1467
  - On the Harvard Forest 1473
  - Opportunities for, by regions 1471
    - Central States 1475
    - Lake States 1475
    - Northern Rocky Mountains 1479
    - Pacific coast 1480
    - South 1476
    - Southern Rocky Mountains 1479
  - Planting 1461
  - Protection from injuries 1462
  - Refraining from cutting 1460
  - Selection of areas for 1469
  - Selective cutting 1459
  - Transportation 1464
  - Weeding, girdling, thinning, and pruning 1456
- Intensive management, forest land, areas (chart) 49
- Interest rates, relation to earning capacity of forests 1131
- Investment, capital, forest, elements of 893
  - Forest land and industries, Pacific coast 914, 915
  - In private forest enterprises, nature of 1125
  - Private forest land 893
    - Liquidation of 898
  - Private forestry 1127
  - Timber, earnings due to growth (table) 909
- Irish Free State, regulation of private forests 1022
- Irrigation, agriculture dependent upon, Colorado River Basin 433
  - Areas served by (table) 302
  - Columbia River Basin 453
  - Great Basin 444
  - Importance of 301
  - Pacific Cascade drainage 459
- Italy, regulation of private forests 1023
  - Wood use 862

J

- Japan, regulation of private forests 1024

K

- Kelley, Evan W., coauthor 1395
  - Acknowledgment 1303
- Kellogg, R. S., acknowledgment to 260
- Kircher, Joseph C., author 1241
- Kirkland, Burt P., acknowledgment 1303
  - Author 891, 1125
- Kneipp, L. F., author 1095, 1147
- Kotok, E. I., acknowledgment 1253
  - Author 1303
  - Coauthor 1395

L

- Lacquer-producing plants 560
- Laird, H. A., acknowledgment to 260
- Lake States:
  - Agricultural land abandonment in 159
  - Forest planting:
    - Needs 1502
    - Problems of 738
    - Range use and 552
  - Opportunities for intensive forestry in 1475
  - Private forestry in 961
  - Significance of Federal cooperation in 1072
  - State aid in 1190
  - Tax delinquency in 876
- Land, abandoned, abandonment. (*See* Abandoned, Abandonment.)
  - Agricultural:
    - Available for forestry 151
    - Changes in area in East (table) 155
    - Decreases in (charts) 156, 157
  - Acquisition program for watershed protection 52
  - Available for forestry, classification (chart) 1232
  - Available for planting (chart) 50
  - Exchanges, as evidence of private ownership breakdown 871

Page
Land, forest:
    Classification proposed 1564
    Commercial classification 146
    Extent and character (table) 122
    National resource 119
    Protective function of 139
    Range resources of 144
    Use for game 143
    Use for recreation 141
  Irrigated, acreage of (table) 302
  Private, taxability in national-forest States (table) 1114
  (*See also* Forest land.)
Land grants:
  To States 1088
  1785–1931 (table) 1089
  Present status 1089
Land management requirements for watershed protection, summary 52
Land use:
  Agricultural future 162
  Anticipated shifts in 1241
  Balancing objectives 1238
  Forest:
    Classification proposed 1617
    Objectives in 1233
    Recreational survey suggested 1543
    Areas now unproductive available for 1485
    As a form of 100, 115
  National policies, and their relation to forest depletion 1589
  Ohio River Basin 391
  Problems of, forest planting as a solution 1492
  Public regulation 994
Landowners, private responsibility for forestry 1593
Larch canker 714
Larch fir type, measures to prevent devastation 1437
Latvia, regulation of private forests 1025
Lawrence College, research in paper chemistry 987
Laws, State forest tax, acreage classified under 802
  (*See also* Legislation.)
Legality, public ownership, forest land 1257
Legislation:
  Authorizing land exchanges within national forests (table) 1163
  Civil service status for State forestry personnel 816
  Federal, administration of fire protection, cooperation 1056
    Aid, results of 1056
    Fire protection 1054
    Weeks law, effect on State forestry 776
  Fish in forest waters 519
  Foreign, controlling private forests 1005
    Defining watershed-protection forests 328
  Forest tax, aiding private owners 1183
    Historical summary 800
    Land classification by State 802
    Relief principle 801
    Wisconsin 1193
    Yield-tax principle 801
  Recreation permits 592
  Needed for Federal forestry program 1631
  Needed for fire-control program 1405
  Regulatory, effectiveness 1004
    State 822
  Required in national forestry plan, summary 74
  Restricting land use by owners 997–1001
  State, aiding private owners 1183
    For forestry purposes, 1885–1911 766
    Forestry 1224
    Needed for forestry program 1606
    Requiring teaching of forestry in schools 785
  Weeks law, acquisition of land under 1171
  Wisconsin, severance tax 1193
Liquidation:
  Private forest land 898
  Policy:
    Effect on forest resource 895
    Pacific coast 911
    Rocky Mountain region 938
Litter:
  Contributes humus to soil 310, 311
  Destroyed in woodland pastures 325

Page
Litter—Continued
  Effect on soil freezing 313
  Influence on percolation 311
Livestock, areas grazed by (table) 528
  Class to which western range best suited 540
  Distribution on watershed ranges 542
  Forest range 527
  Grazing, in re wild-life management 498
  Indian forests 621
  Land needed for 1235
  Southern forest range 547
  Western range, management problems 535
  (*See also* Grazing, Overgrazing, Range, Forage.)
Locust borer 729
Lodgepole pine type, measures to prevent devastation in 1443
Logging, costs versus log prices, Columbia River (chart) 924
  Effect on run-off and erosion 321
  Equipment and methods, research 1378
  Ponderosa pine type 1442
  Practices needed to prevent devastation on private land (table) 1451
  Selective. (*See* Selective logging.)
  State regulation of 823
  Sugar pine-ponderosa pine 1440
  (*See also* Cutting, Lumbering.)
Longleaf-slash pine type, measures to prevent devastation in 1444
  Practices to prevent devastation in (table) 1452
  (*See also* Pines, southern.)
Lookouts, Indian forests (table) 626
  State fire protection 818
Losses, timber, versus growth 205
  Volume 218
Lower Mississippi River Basin:
  Map 359
  Stream-flow and flood problems 413–416
Lumber companies, forest planting by 1491, 1498
Lumber:
  Construction material, competition 251
    Trends in use of 249
  Consumption (table) 247
    Estimates normal (table) 256
    Hardwoods versus softwoods 257
    Rural 249
    Trends (charts) 246, 247
  Direct-to-construction, consumption of (table) 249
  Drain on 212
  Imports and exports (table) 247
Lumber industry:
  Migration of 192
  Statistical position, Lake States (table) 963
Lumber manufacturers, research by 992
Lumber production, United States (tables) 216, 247
Lumber production, United States (chart) 212
  And consumption, Central States (table) 959
    Lake States (table) 963
    New England and Middle Atlantic States (table) 969
    Pacific coast (table) 913
    Rocky Mountain region (table) 933
    South (table) 940
Lumber, requirements, estimated normal 256
  Use in construction, factors affecting trends in 249
  Use in manufacture (table) 253
Lumbering, Indian forests 624
  Ohio River Basin 391

M

McAtee, W. L., acknowledgment to 495
McSweeney-McNary Forest Research Act 683, 1556
  Expenditures (table) 1557
  Modifications in national forestry plan 75
  Proposed amendments 1631
  Provision for pathology research 1137
Madagascar, regulation of private forests 1015
Maine, forest policies of 734
Major problems and the next big step in American forestry (section) 1
Mammals, a forest resource 489
Management:
  Business, of national forests 602
  Costs:
    National forests (table) 1306, 1307
    New national forest units (table) 1316, 1318

Page
Management—Continued
Costs—Continued
Private forests (table) 1320
State forests 1318
Distribution of volume in residual stands (charts) 906, 917, 922, 923, 926, 929, 934, 944, 949, 970, 972, 973, 974, 976.
Fishery 510, 516
Management:
Forest. (*See* Forest management.)
Forest lands:
Financial capacity of States for (table) 1297
Future areas (table) 1281
Income 1320
Intensive 1455
Private, need for planning in 979
Watershed protection, summary 52
Forest range:
Program of 1537
Public and private (chart) 18
Growth under different types of (table) 231
Income:
Public forests (table) 1322
Private forests (table) 1323
Indian forests 614
Land, requirements for adequate watershed protection 1532
National forest:
Program, legislation needed for 1631
Program, proposed 1619
National forest land, costs, reasons for increase 1308
National forest resources 577
Range:
National forests 587
Western problems of 535
Resource, on representative national forests (table) 1307
Restrictions, Federal regulation 1348
Sustained yield possibilities 228
To meet wood requirements 241
Types of:
Areas allocated to (table) 231
Defined 231
Southern pines 945
Timber:
Cost on national forests 1310
Even-aged forest (chart) 904
Extensive, areas, summary 43
Intensive, areas, summary 43
Plans, on national forests 580
Selection forest (chart) 905
Wild-life 501
Woodland, Federal aid in 1213
Management systems, allotment of forest areas under (table) 1282
Manti Canyon, Utah, floods on 447
Manufacture:
Lumber consumption in (table) 254
Paper, raw materials consumed in (table) 259
Naval stores consumption in (table) 273
Manufacturing plants, unwise location and excess construction 898
Maple sirup, a forest byproduct 555
Market:
Forest products, measures for holding 1357
Timber, foreign, relation to domestic supplies 240
Marshall, Robert, author 463, 633, 1543
Marsh, R. E., coauthor 121, 173
Massachusetts, forest policies of 735
Mechanical pulping process, wood requirements (chart) 269
Medicinal barks 557
Mellon Institute of Industrial Research 988
Merchandising, forest products 1364
Merrick, G. D., acknowledgment 527
Methods, logging, equipment, research 1378
Methods of harvesting forest products research in 676
Mexico, regulation of private forests 1025
Michigan Forest Fire Experiment Station 795
Michigan University, forest research by 986
Middle Atlantic States:
Agricultural land, abandonment in 158
Contrasting forest policies in 736
Forest range use in 552
Private forest conditions and management in 966
Significance of Federal cooperation in 1071
State aid in 1188

Page
Migration of forest industries 192
Mill stocks, 1923–31, changes in (table) 247
Mill waste, utilization, prevention, research 1385
Millwork, consumption of lumber for (table) 249
Mining, effect on world wood use 293
Mining property, Central States, forest management of 957
Minnesota University, forest research by 986
Minor byproducts of the forest (section) 554
Mississippi bluff lands and silt loam uplands, critical watershed problems in 1521
Mississippi River:
Contribution of Arkansas and Red Rivers to 404
Contribution of Missouri River to 400
Floods 412
See also Lower Mississippi River Basin and Upper Mississippi River Basin.
Missouri Botanical Gardens 990
Missouri River Basin (map) 396
Missouri River Basin:
Lower 398–402
Upper 397–398
Mistletoe 700, 1420
Modification, properties of forest products, research in 678
Moisture proofing, forest products, research in 1370
Mold, injury to forest products 707
Monuments, national. (*See* National monuments.)
Moose, on national forests (table) 493
Morrell, Fred, author 1203
Mortgage foreclosure, private ownership breakdown 872
Multiple-use, public ownership, forest land 1294
Munger, Thornton T., author 869, 1455
Municipal forests, watershed-protection conditions and requirements on 1515
Municipal forests 843–845
Municipal parks, administration of, summary 484
Municipal land, forest wild life, areas on 1552
Munns, E. N., coauthor 1231, 1509
Munns, E. N., acknowledgment to 173
Mycorrhiza 697

N

National Academy of Sciences, contribution to forestry 8
National Committee on Wood Utilization 1146
National Forests, section 565
Acquisition program 574, 1175
Acquisition recommended, cost of management, summary 72
Acts authorizing land exchanges (table) 1163
Adequacy of protection (chart) 599
Administration 602
Costs, existing 1624
Cost of proposed additions (table) 1626
Efficiency (chart) 603
Program, proposed 1619
Summary 483
Alienated lands (table) 569
Alternatives to creation of 1110
Appropriation increases needed for proper management 1313
Areas:
By regions (table) 569
Present and prospective (table) 1264
Area burned versus rainfall (chart) 596
Area burned versus recreation use (chart) 597
Average annual expenditures, summary 71
Benefits:
To counties 1098, 1105
To States 1098, 1105
Big-game population (table) 493
Contributions:
To public welfare 1100
To States and counties (table) 1106
Costs 1305
Of administration 1104
Fire protection (table) 1409
Protection, management (tables) 1306, 1307
Creation and contribution 565
Development of 1168
Disease control 601
Donations of land to 1167

Page

- National Forests, eastern, development of 1171
  - Effect on costs of local government, 1923–27 (table) 1108
  - Enterprise, summary 2
  - Expenditures for local administration, 1923-27 (table) 1104
  - Expenditures, segregation, capital-investment, and current charge increases 1314
  - Financial status, 1923–27 1104
  - Fire control:
    - Allowable burn (table) 1399
    - Costs (table) 1409
    - Financial program 1413
    - Ratio of allowable to actual burn (tables) 1400, 1402
  - Forage use on 586
  - Form of Federal aid to the States 1095
  - History of 1096
  - Income 1323
    - Contributed to States 1326
    - Grazing 1324
    - Prospective 1636, 1637
    - Recreation 1324
    - Watershed 1325
  - Insect control 600
  - Land closed to hunting (table) 508
  - Losses to States if administered as State forests (table) 1121
  - Management and use of resources of 577
  - Net gain to States compared to alternative uses (table) 1122
  - New units, cost of management and protection (tables) 1316, 1318
  - Planting, 20-year program 1506
  - Possible gross income 1325
  - Potential taxability of lands (table) 1114
  - Primeval areas reserved (table) 473
  - Probable effects of State ownership of 1118
  - Program 1587
    - Legislation needed for 1631
  - Property, how built up 569
  - Proposed additions from public domain (map) 573
  - Purchase program under Weeks law 1171
  - Range areas on 544
  - Range management on 587
  - Receipts and expenditures (table) 605
  - Recreational values 1101
  - Recreational use 591
  - Regional map 570
  - Relationship to forest situation 1095
  - Replanting, progress 585
  - Representative costs, resource management, fire protection (table) 1307
  - Reservation Commission, creation of 1166
  - Southern, area grazed 551
  - Streams heading in (map) 589
  - Study of relationships, 1923–27 1101
  - Suggested additions from public domain 646
  - System, development and present status 1168
  - Theoretical results of private and State ownership of 1116
  - Theoretical returns from private and State ownership (table) 1117
  - Timber returns 1323
  - Total area (chart) 1097
  - Visitors to (tables) 465
  - Water conservation 589
  - Western, development of 1170
  - Wilderness areas 473, 476, 485
  - National Monuments 633
  - Administration summary 482
  - Names, locations, areas, etc. (table) 636
  - National Parks 633
  - Administration, summary 482
  - Closed to hunting (table) 508
  - Fire-control financial program 1413
  - Fire protection 635
  - Forest area of 633
  - Forestry program, proposed 1611
  - Insect control policy 1416
  - Names, locations, areas, etc. (table) 634
  - Progress, summary 4
  - Standards of establishment 633
  - Visitors to (tables) 465
  - Watershed-protection conditions 1517, 1519

Page

- National plan for American Forestry:
  - Activity programs required, summary 42
  - Agency programs required, summary 57
  - Capital investment required, summary 72
  - Cost and financing, summary 71
  - Essentials summarized in national plan 76
  - Financing, summary 74
  - Forest-land management 241
  - Legislation required, summary 74
  - Need for, to attain forestry objectives 40
  - Programs required and responsbility for them, section 1229
  - Saw timber as major object 235
- Natural reforestation, progress and requirements of research 670
- Naval stores:
  - Consumption (table) 273
  - Harvesting, research 1379
  - Production 272
    - Table 273
    - Management for 955
  - Research by Bureau of Chemistry and Soils 1566
  - Timber, availability 203
- Navigation:
  - Facilities, Federal expenditures (table) 303
  - Northeastern drainages 334
  - Ohio River Basin 386
  - South Atlantic drainages 345
- Netherlands, regulation of private forests 1026
  - Wood use 286
- New England:
  - Agricultural land abandonment in 157
  - Contrasting forestry policies in 734
  - Forest range use in 552
  - Forest research projects, 1932 (table) 792
  - Private forest conditions and management 966
  - Significance of Federal cooperation in 1071
  - State aid in 1185
- New England and Middle Atlantic States:
  - Forest-planting needs 1501
  - Opportunities for intensive forestry 1472
- New Hampshire, forest policies 734
- Newsprint consumption:
  - Table 259
  - Trends in 263
  - Versus newspaper size (chart) 262
- New York:
  - Development of State forestry activities in 753
  - Forest policy in the Adirondacks 759
  - Forest research projects 1932 (table) 792
  - Problems in development of State forestry 756
  - Reforestation program 799
- Noncommercial forest land, ownership, present and proposed (chart) 69
- Noncommercial land ownership (chart) 11
- North coast drainages, California watershed conditions on 423
- Northeastern drainages:
  - Critical watershed problems 1526
  - Map 332
  - Watershed conditions 331, 338
- North Rocky Mountain region:
  - Significance of Federal cooperation in 1073
  - State aid in 1199
- Norway, regulation of private forests 1026
- Nurseries, forest:
  - Diseases affecting 695
  - State facilities 799
  - Technique, fires, etc 1495
- Nuts and seeds, edible 558

O

- Oak, hardwoods, well-stocked stand, Mont Alto State Forest (table) 974
- Objectives, fire control 1397
  - Allowable burn (table) 1399
  - Criteria regarding 1397
- Objectives:
  - Forest research 651
  - Forest wild-life program 1547
  - Forestry, major, and a national plan 40
  - Saw-timber production as 235
  - Research, past, present and future 682
  - Timber management on national forests 580
- Obligations, public, public regulation 1349
- O'Donnell, C. M., coauthor 733

Page

- Ohio River Basin 380–393
  - Floods 381
  - Lumbering 391
  - Map 379
  - Topography 369
- Old-growth saw-timber stand, U.S. (charts) 175
- Old-growth timber areas (chart) 128
- O'Malley, Henry, author 510
- Oregon and California Railroad land grant 647
- Oregon, tax delinquency (tables) 873–874
- Organization:
  - Development and facilities of, research 655
  - Industrial, forest products 1358
  - National forest, administrative efficiency (chart) 603
- Ornamental forest plants 558
- Other Federal activities as forms of State aid (section) 1135
- "Outing areas" for recreation 479, 486
- Overgrazing:
  - Effect on run-off and erosion, from forest ranges 322
  - Effects on woodland pastures 325
  - Farm woodlands 554
  - Influence on watershed values, Columbia River Basin 457
  - Range management problem 535
  - Relation to watershed values in San Joaquin River Basin 422
- Owners, private. (*See also* Ownership.)
  - Private:
    - Need for improved practices by 1038
    - Attitude toward public acquisition by 1147
    - Restrictions on, in United States 997
    - Share of protection costs in certain States by 807
    - State aid received by (charts) 1179, 1185, 1186
- Ownership:
  - Abandoned farm land, future 1275
  - Agricultural land, decreases in (charts) 156–157
  - Commercial forest lands:
    - Distribution (table) 131
    - Farm woodlands 136
    - Industrial 130
    - Public 137
  - Commercial and noncommercial land, present and proposed (chart) 69
  - Cordwood stands (chart) 188
  - Effect on State or county resources (chart) 1122
  - Farm woodland, future 1276
  - Federal:
    - Cordwood stands (table) 188
    - National forests 565
    - Saw timber (table) 185
  - Forest land:
    - Anticipated shifts in 1242
    - Areas of (chart) 11
    - Central States, classification of 957
    - Effect of Federal acquisition on 1161, 1162
    - Future 1253, 1280
    - Future acquisition by public agencies (table) 1298
    - Future distribution, by public agencies 1296
    - Lack of balance in (chart) 77
    - Missouri River Basin:
      - Lower 401
      - Upper 398
    - Northeastern drainages 338
    - O and C and Coos Bay land grants 647
    - Ohio River Basin 392
    - Pacific coast 931
    - Present (table) 1255
    - Present and planned (chart) 52
    - Private (charts) 134–135
    - Private, consolidation and stabilization of 979
    - Private, financial aspects of, Pacific coast 913
    - Private, Lake States 963
    - Private, New England and Middle Atlantic States 966
    - Private, problems of 891
    - Private, stabilization of 900
    - Public (charts) 136–138
    - Public, transfer from private 884
    - By States, desirability of 1262
    - Use by game, in relation to 502
    - Watershed protection value by (table) 1286
  - Forest productivity (chart) 26

Ownership—Continued Page

  - Forest range, areas (table) 528
  - Forest, relation to watersheds, summary 27
  - Future, of private commercial forest land (table) 1272
  - Future public, areas for timber production (table) 1283
  - Land, bearing on critical watershed situations 1522, 1523, 1524, 1525, 1527, 1528, 1529, 1530, 1531, 1532, 1533
    - Need of forest planting by 1506
    - Public domain disposal plan 644
    - Public domain, history of 637
    - Watershed conditions and requirements correlated with 1512
    - Yazoo River watershed 417
  - National forest areas, present and prospective (table) 1264
  - Nature of investment in forest enterprises by 1125
  - Private:
    - Acts authorizing land exchanges (table) 1163
    - Administration and management of forest land, summary 16
    - Aided by public land acquisition 1147
    - Annual cost of State-aid for (tables) 1178–1179
    - Area industrial timberland, future 1271
    - Area industrial timberland, growth classes, future (table) 1273
    - Complementary to public 1259
    - Contribution to forestry, summary 7
    - Cordwood stands (table) 188
    - Cost of share in national plan 72
    - Effect on forest industries 15
    - Effect on public welfare, summary 16
    - Essential obligations in national plan 76
    - Evidences of breakdown in 870
    - Failure of laissez-faire policy of, summary 41
    - Financing share in national plan 72
    - Forest land, basis 1256
    - Forest land, situation 869
    - Industrial (charts) 130–134
    - Industrial timberland, factors influencing permanence 1265
    - Instability, summary 14
    - Limiting factor in timber supply, summary 23
    - Place in national forestry plan, summary 58
    - Possible forest income, summary 73
    - Present status of 1153
    - Possible forms of public aid to 1155, 1157
    - Problems of, summary 11
    - Program for watershed protection, summary 53
    - Projects receiving State aid (table) 1180
    - Public aid to, in national plan, summary 60
  - Range lands 547
    - Regulation of lands in, in national plan, summary 64
    - Responsibility for devastation and deterioration, summary 12
    - Saw timber (table) 185
    - Share in forestry expense (chart) 10
    - State aid in fire protection to 1180
    - State aid in forestry to 1177
    - State aid in forest planting to 1181
    - State regulation of 822
    - Tax-reverted land, problems of, summary 21
    - Watershed values, degree conserving 1287
  - Public:
    - As aid to private forestry 1147
    - Complementary to private 1259
    - Essential obligations of, in national plan 76
    - Estimated returns of, in national plan, summary 73
    - Forest land, basis 1256, 1259
    - Forest land, basis division between agencies 1261
    - Forest land, multiple use of 1294
    - Justification of, summary 67
    - In national plan, summary 67
    - Program for, cost, summary 71
    - Purposes of 1158
    - Relation to responsibility for forestry 1593
    - Remedy for forest exploitation 994
    - Share in forestry expense (chart) 10
    - Share in forestry enterprise (chart) 78

Ownership—Continued Page
Public—Continued
Timber production through 1278
Watershed areas recommended for (table) 1293
Watershed protection 1286
Watershed protection areas feasible for 1291
Responsibilities, costs, and returns (section) 1303
Saw timber (tables) 185, 187
Saw timber stand, U.S. (chart) 186
Share of devastated land (charts) 12
Share in forestry activities (chart) 19
Share in timber-growing job (chart) 69
Southern forest range 551
Stability prerequisite to forestry 1253
State:
Definition of 824
Areas in 824
Cordwood stands (table) 188
Forest areas, present and prospective (table) 1264
Forest land 823
Importance in fire protection 819
Saw timber (table) 185
Timber supplies 184
Watershed conditions classified by:
Colorado River Basin 437
Columbia River Basin 456
Pacific Cascade drainages 460
Upper Rio Grande Basin 443
Western forest range 544
Woodland, on farms, future (table) 1278
Ozark-Ouachita:
Forests, conditions in 408
Area, critical watershed problems 1527

P

Pacific Cascade drainages:
Floods 458
Irrigation 656
Map 451
Water supplies, demand for 458
Watershed conditions on 458
Watershed conditions classified by ownership 459
Waterpower resources 458
Pacific coast:
Forest planting needs 1504
Opportunities for intensive forestry 1480
Private forest conditions and management 911
Pacific coast region, significance of Federal cooperation in 1073
Pacific slope dense forests, critical watershed problem 1529
Pacific States, State aid in 1198
Paint and varnish research 991
Painting, forest products, research 1370
Paper:
Consumption by kinds (chart) 261
Consumption of, by kinds (table) 259
Consumption, per capita (chart) 258
Consumption trends in 262
Consumption, world's (table) 293
(*See also* Pulp.)
Paper boards. (*See* Boards, paper.)
Paper industry, Lake States (table) 963
Paper machine operating, research 1385
Paper:
Manufacture, material, raw, consumed in (table) 259
Requirements, future 263
Imports (table) 265
Parasites:
Insect 731
Plant 695
Parks, national. (*See* National parks.)
State. (*See* State parks.)
Pathology, forest:
Federal activities in 1135
Projects in 695
Research and control, status of 717
Research, private and quasi-public 987
Pecans 557
Pennsylvania, development of State forests in 763
Pennsylvania Forest Research Institute 794
Percolation, influence of forest cover on 311
Personnel:
Indian forests 628
Needed in research 665

Page
Physiography, upper Mississippi River Basin 369
Piedmont Plateau, erosion on 342
Piedmont and upper coastal plains, critical watershed problems 1523
Pine (s):
Longleaf and slash, Florida (table) 950
Longleaf and slash, management for naval stores production 955
Shortleaf and loblolly, stands in southern Arkansas (table) 946
Southern, intensive management of 1477
Selective cutting of 952
Stands and increments (table) 944
Typical stands, condition and management 945
White, enemies, disease 712, 714
Enemies, insect 729
Piñon seed industry 557
Pisgah game preserve management plan 504
Plan, national. (*See* National plan.)
Planning, national, to attain forestry objectives 41
Plant Industry, Bureau of:
Author 1419
Forest pathology activities 695, 1135
Forestry program, proposed 1613
Plantations, forest diseases affecting 696
Planting, area available for, and 20-year program (chart) 50
Areas covered by (table) 1497
Characteristics of cut and burned sites (table) 1493
Costs 1497
Costs, estimated 1508
Difficulties of 1493
Diseases relating to 1419
As an element of intensive forestry 1461
Expenditure (chart) 20
Federal aid 1336
Forest, accomplishmens 1496
Forest Service 20-year program 1506
Industrial, success of 1498
By lumber companies 1491
As mode of unemployment relief 1492
Nursery methods 1495
National forests 585
Program, summary 50
Reasons for 1488
Regional, aspects of Federal aid 1078
Regional needs for 1501
Results of Federal cooperation in 1077
Site characteristics, study needed 1493
Source of seed for 1494
State aid to private owners in 1181
State share, regulation 1350
Survival 1497
Timber production 1490
20-year program of 1500
Watershed protection 1488
(*See also* Reforestation.)
Watershed protection, Columbia River Basin 457
Great Basin 449
Pacific Cascade drainages 460
Upper Rio Grande Basin 444
Plywood, world production 294
Poisonous plants on the range 543
Poland, regulation of private forests 1028
Policies, forestry:
(*See also* forestry policies.)
Foreign, in private forest regulation 1037
Ponderosa pine:
Lodgepole pine belt streamflow, importance of 1530
Measures to prevent devastation 1441
Table 1452
Typical stand, eastern Oregon (table) 930
Portugal, regulation of private forests 1028
Possible program of public regulation (section) 1343
Posts, fence, drain 217
Power, water, industrial importance of (table) 302
Precipitation:
Arkansas and Red River drainages 405
Deficiency and fire on national forests 596
East Gulf drainages 351
Interception by forest cover 308

Precipitation—Continued Page
  Mississippi River Basin, upper 370
  Missouri River Basin, lower 400
  Ohio River Basin 380
  Quantity and distribution 306
Precipitation and run-off (chart) 319
Predators on forest range 544
Preservation, wild life, on national forests 593
Prevention, mill waste, research 1385
Price indices:
  Cotton versus southern yellow pine (chart) 943
  Log versus logging costs, Columbia River (chart) 924
  Selling versus production costs, ponderosa pine (chart) 938
  Stumpage, trend, southern yellow pine (chart) 942
"Primeval areas" for recreation (tables) 471, 473, 485
Private agencies, forest research, program for 1571
Private forests:
  Administration, summary 484
  Conditions, regional 896–911
  Cordwood on 893
  Economic size 900
  Extent 892
  Investment in 893
  Financial aspects of Pacific coast 913
  Potential productivity (chart) 26
  Saw timber on 893
  Stabilization 900
  Sustained yield practice on 896
Private forest land:
  Cut-over annually (chart) 13
  Expenditures needed to prevent devastation 1451
  Fire control, allowable burn (table) 1399
  Under management (charts) 17
  Forest, wild life management on 1549, 1551
  Protected and unprotected (chart) 13
  State, fire protection costs (table) 1408
  Used by game 507
  Watershed-protection conditions and requirements 1513
Private forestry:
  Distribution of volume in residual stands after cutting (charts) 906, 917, 922, 923, 926, 929, 934, 944, 949, 970, 972, 973, 974, 976.
  Financing of 1125, 1129
  Status and opportunities of 891
Private land, agricultural, watershed protection, conditions and requirements 1512
Private owner, or ownership. (*See* Ownership, private).
Private share:
  In fire costs (table) 819
  In forest activities (chart) 19
  In forestry expenditures (chart) 10
Probable future distribution of forest land ownership (section) 1253
Products, factory, lumber consumption in 253
  Farm, research 1372
  Forest. (*See* Forest products.)
  Marketable, lower costs forest products research 1372
Production, forage:
  Eastern United States 552
    South 547
    Western 530
  Forest products, improvement 1362
    Small timber holdings 1361
  Lumber (table) 247
    United States (chart) 212
  Naval stores (table) 273
  Pulp, world's (table) 293
  Timber:
    Areas, future public ownership (table) 1283
    Land needed for 1235
    National forest (table) 576
    Needed areas, summary 43
    Public land acquisition (table) 1295
    Public share in (chart) 78
    Timber, provision for, summary 44
    Wild life and 497
Productivity, potential forest land (chart) 26
Protection:
  Against fire (section) 1395
  Against forest diseases (section) 1419
    Agencies needed 1422

Protection—Continued Page
  Against forest insects (section) 1415
  Allowable burn (table) 1399
  Costs, national forests 1306–1307
    New national forest units 1316–1318
  Disease, Indian forests 627
    Program, summary 46
  Expenditures, national forests (tables) 1408–1409
  Federal regulation 1349
Protection, fire:
  Adequacy on national forests (chart) 599
  Areas and costs, 1915 and 1931 (table) 1057
  Benefits to State from 804
  Cooperative, areas involved (chart) 1059
    Expenditures (charts) 1061, 1067
  Cost on national forests 1308
  Costs on representative national forests (table) 1307
  Development of as State policy 764
  Distribution of costs of 1065
  Efficiency 813
  Expenditure (chart) 20
    State, regional, per acre 809
  Federal aid to States 1208, 1332
  Financing of 1060
  Growth of as cooperative activity, 1911–31 (table) 776
  Indian forests 626
  Land abandonment, lessens 803
  Major activity of State forestry organizations 805
  National forests 595
  Need for trained personnel 815
  Organized, area covered by 1059
  Prevention, stressed by States 806
  Program, summary 44
  Progress and requirements of research 672
  Results of Federal aid in 1074
  Significance of Federal cooperation by regions 1071
  Simple, defined 230
  Standards 811
  State, aid in 803
    Developments and difficulties 814
    Equipment for 805
    Financing 807
    Organizations and methods 805
    Personnel, selection of 807
    Private owners, to 1180
    Private progress in, and (chart) 1059, 1061
    Providing for regulation (map) 1000
    Regulation 1345
    Results (tables) 807, 809, 814
    Share, regulation 1350
  Forests, as an element of intensive forestry 1462
  Forest diseases, organized control 1423
    Cost on national forests 1309
  Forest insects, cost on national forests 1309
    Indian forests 627
    National forests 600
    Program, summary 46
    State activity 821
    State, Federal aid 1336
    State regulation 1345
  Forest land, needed and given (chart) 13
  National forests, area burned versus precipitation (chart) 596
    Area burned versus recreation use (chart) 597
  Public interests, State regulation 1346
  Recreation areas 480
  Regulation, Federal Government 1351
  State and private land versus burns (chart) 1070
  Watershed, areas feasible for public ownership 1291
    Areas recommended for public ownership 1293
    Forest land ownership (table) 1286
    Indian forests 623
    Private land, degree conserving values 1287
    Problems of, summary 25
    Program summary 51
    Public acquisition, objective 1291
    Public acquisition, private areas (table) 1288
    Public forests, establishment, limiting factors 1288
    Public land acquisition (table) 1295
    Public ownership 1286
Pruning as an element of intensive forestry 1456

Page
Prussia, protection forests in 1018
Public acquisition, an aid to private forestry 1147
Public aid:
  Expenditure (chart) 20
  Federal, State, 1935–39 compared 1932 (table) 1340
  Principles underlying 1329
  State and Federal, 20-year program (table) 1341
  (*See also* Aid, public.)
Public:
  Commercial forest land owned by 137
  Contribution to forestry (chart) 10
Public domain:
  Additions to national forests from 569
  Administration, summary 483
  Areas valuable for watershed protection 639
  Disposal plan 644
  Other Federal forest land (section) 637
  Fire control, financial program 1412
  Fire protection 641
  Forest-land area 639
  Forest range on 546
    Program summary 55
  History 637
  Management recommended for watershed protection 1536
  Probable receipts from management 647
  Problems of, summary 21
  Proposed additions to national forests (map) 573
  Range management 642
    Problems 1538
  States and counties, problems of, summary 22
  Timber areas 640
  Timberland management 640
  Watershed-protective conditions and requirements 1520
  Watershed protection needed 643
  Potential productivity (chart) 26
Public forest regulation. (*See* Regulation, public.)
Public:
  Forestry extension needs 1582
  Hunting grounds, State 830
  Land cut over annually (chart) 13
    Under forest management (charts) 17
    Protected and unprotected (chart) 13
Public obligations. (*See* Obligations.)
Public ownership. (*See* Ownership, public.)
Public regulation of private forests (section) 993
  State, summary 7
Public share in forest activities (chart) 19
Puerto Rico, forest conditions and problems 1641
  Forest conditions and problems 1646
Pulp:
  Consumption (table) 259
  Mills, investment in Pacific coast 915
  Requirements 261–263
  And paper, research 1379
  Research 990
  Wood used for (table) 182
  World production (table) 293
  World wood use for 293
  (*See also* Paper.)
Pulping new species 1382
  Processes, improvement 1381
  Wood requirements of 195
Pulpwood:
  Drain 217
  Industry, Lake States (table) 963
  Production, Lake States 961
    South 941
  Requirements 258
    Domestic and imported (chart) 267–269
    Imports 264
  Supplies 182
    Availability 195
Purchase areas, national forests, by regions (table) 569
Purchase units in national forest program 574

Q

Quarantine:
  Bureau of Plant, proposed forestry program 1614
  Federal plant 715, 720, 1135, 1140
Quasi-public expenditures (chart) 10
Quasi-public forest research, program, summary 57

R Page

Rags, consumption in paper manufacture (table) 259
Railroads, effect on world wood use 292
Railways, steam, mileage (table) 271
Rainfall. (*See also* Precipitation, run-off.)
Range, forest:
  And forest influences 675
  Extent and distribution 144
  Investigations by Forest Service 1559
  Land needed for 1235
  Livestock, forests as 95
  Management, public domain 642
    Public and private 18
  National forest, use 586
    On national forest 586
    Overgrazing on 322
  Western, management principles 540
  (*See also* Forest range.)
Rayon, pulp requirements for 263
  World production 294
Receipts and expenditures, national forests 605
Recreation, forest 463
  Administration 482
  Camp-sites areas 477, 486
  Cost of management, national parks 1312
  Evaluation 464
  Factors in 465
  Forest Service program proposed 1621
  General problems 479
  Income from, possible 1324
  Indian forests 624
  Investments in 465
  Land needed for 141, 1234
  On national forests 590
  "Outing areas" 478, 486
  "Primeval areas" 472, 485
  Problems, summary 29
  Program for 53, 1543
  Public land acquisition (table) 78
  Public share in (chart) 78
  Purposes 468
  Relation of forestry to 484
  Reservation for (table) 143
  Residence areas 478, 486
  Roadside areas 476, 486
  Source of 93
  "Superlative areas" 471, 485
  Survey proposed 1543
  Types of areas for 53, 470
  Use for, relation of disease to 705
  Volume and value 465
  Wild life values in (table) 495
  Wilderness areas 473, 476, 485
Recreationists on forest land (table) 465
Red River drainage (map) 359
Red spruce, flat type, White Mountains (table) 972
Redwood type, measures to prevent devastation in 1443
Reforestation. (*See also* Planting.)
  Agricultural land available for 152, 166
  National program of 1485
  Natural, estimated areas (table) 1488
    Satisfactory minimum stocking 1488
    In the South 1504
  Planting, on national forests 585
  Retarded by insect activities 729
  State, activities and policies 798–9
Refuges, game, State 830
Regions, forest. (*See* Forest regions.)
Regional interdependence for timber supplies 237
Regulation(s):
  Cutting 1002
  Federal, enforcement 1349
    Protection forests, classification 1347
    Restrictions on management 1348
    Scope 1347
  Fire protection, States' share 1350
  Mandatory, obstacles to 1045
    Practices justifying 1042
  Optional, proposed policy 1039
  Of private forests, desirability in United States 1038
  In national plan, summary 64
  Planting, States' share 1350
  Policies abroad 1037

- Regulations—Continued — Page
  - Public, arguments for and against 1047
    - Cost 1351
    - Desirable policies 1044
    - Division of responsibility 1343
    - Federal responsibility 1344
    - Obligations 1349
    - Of private forests, as remedy for exploitation 994
    - Of private property 995
    - State, scope of 1345
  - State 821
    - Cutting 1346
    - Fire protection 1345
    - Insects, disease 1345
    - Providing for control of subsidized forests (map) 1002
    - Requiring fire protection (map) 1000
    - Requiring slash disposal (map) 998
    - Responsibility 1344
    - Taxation, State 1350
- Reproduction, forest, grazing, damage to 537
- Requirements:
  - In research 669
  - Lumber, estimated normal 256
  - Paper, future 263
    - Relation of imports to (table) 265
  - Plan for forest management to meet (table) 242
  - Pulp, for cellophane 263
    - For paper boards 261
    - For rayon 263
  - Pulpwood 258
    - Imports in relation to 264
  - Silvicultural, of forest land owners 1002
  - Timber, area needed for (chart) 48, 49
    - Area needed to meet, summary 43
    - General outlook 277
    - Growing stock needed to meet (table) 233
    - Growth necessary to meet (table) 232
    - National 245
    - National, areas needed 1280
    - Normal, present and prospective 236
    - Summary 23
  - Wood, national, a major forestry objective 40
    - Russia (table) 288
    - World's continuous 296
- Research, better use of wood 1367
  - Forest, entomology 1564
    - Erosion-streamflow 1563
    - Expenditures (table) 1557
    - By Federal agencies 1555
    - Federal program, proposed legislation needed for 1631
    - Forest biology 1566
    - Forest economics 1562
    - Forest land classification 1564
    - Forest products 1560
    - By the Forest Service as a form of State aid 1140
    - Forest Service, program for 1556
    - Forest Service program, proposed 1616
    - Fire weather 1568
    - National arboretum 1568
    - National institute of, recommended 1573
    - Naval stores 1566
    - Need for Federal aid to States 1216
    - In nursery technique, some findings 1495
    - Management 1557
    - Pathology, Federal 1135
    - Products. (*See* Forest products research.)
    - Program for 1555
    - Program of State expenditures involved (table) 1607
    - By quasi-public and private agencies 1571
    - Range investigations 1559
    - Forest Service 1140
    - State 1183
    - By States 1569
    - State, expansion proposed 1603
    - (*See also* Forest research.)
- Reseeding:
  - Forage recommended for watershed protection:
    - Columbia River Basin 457
    - Great Basin 449
    - Upper Rio Grande Basin 444
- Reseeding western ranges 539
- Reservations, Indian, forest land and timber (table) 612

Page

- "Residence areas" for recreation 478, 486
- Resolution, Senate, 57 II
- Resources, forest, Indian reservations 607
  - Grazing land, Indian forests 621
  - National-forest land 119
  - National forest, management and use 577
  - Natural, results of too rapid exploitation of 106
  - Timber, present and potential 173
  - Wild life, State 830
- Restrictions on use of fire by forest-land owners 998
- Restocking areas, industrial (chart) 134
  - And planting program (chart) 50
  - Present and proposed (chart) 225
  - Public (chart) 136
  - Timber stand (chart) 178
  - Woodland (chart) 135
- Revegetation of western ranges 539
- Revenue, national forests, new sources, now free 1324
- Ringland, Arthur C., acknowledgment to 288
- Rio Grande Basin, lower (map) 359
- Rio Grande. (*See also* Upper Rio Grande Basin.)
- Rio Puerco River, N.Mex., floods and erosion on 439
- Roads:
  - Federal-aid, cost (table) 1087
  - Necessity of, for intensive forestry 1464
  - And trails, Indian forests (table) 626
- "Roadside areas" for recreation 476, 486
- Roberts, Paul H.:
  - Author 1547
  - Coauthor 489, 1587
- Rocky Mountain forests: Arkansas and Red River drainages, conditions in 407
- Rocky Mountain region, northern:
  - Forest planting needs 1504
  - Opportunities for intensive forestry 1479
  - Private forest conditions and management 931
- Rocky Mountain region, southern:
  - Forest planting needs 1505
  - Opportunities for intensive forestry 1479
- Rodents on forest range 544
- Rosin. (*See* Naval stores.)
- Rotation grazing 539
- Rubber, native forest plants containing 560
- Rumania, regulation of private forests 1029
- Run-off. (*See also* Stream flow.)
  - From agricultural land, increase with slope 327
  - From burned areas, southern California 427
  - Effect of fire on 316
    - Logging on 321
  - Influence of forest cover on 306
    - Litter on 310
  - Ohio River Basin 387
  - From overgrazed forest ranges 323
  - And precipitation (chart) 319
  - In Yazoo River flood, measurements of 416
- Russia, regulation of forests 1030
  - Wood requirements, 5-year plan (table) 288
  - Wood use 287

S

- Sacramento River Basin, watershed conditions in 422
- St. Lawrence River Basin:
  - Dune lands 366
  - Erosion problems of 366
  - Lower (map) 332
  - Mountain areas 366
  - Upper (map) 371
- Sales, timber, management on national forests 582
- San Joaquin River Basin, watershed conditions in 421
- Sap stain of lumber 707
- Sawmills, investment in Pacific coast 914
- Saw timber:
  - Areas:
    - Industrial (chart) 134
      - Public (chart) 136
      - Woodland (chart) 135
  - Cull due to decay in (table) 702
  - Cut and destroyed annually (table) 207, 208–209, 74b, 75a
  - Cut, use, and growth (chart) 238

Saw timber—Continued Page
  Drain:
    Charts 209–212
    And growth (chart) 24
  European consumption (table) 288
  Future growth and drain (table) 223
  Growth (table) 79a
  Major objective in national plan 235
  Ownership (tables) 185, 187
  Present and proposed stands (chart) 226
  On private land (table) 893
  Producing areas, present and proposed (chart) 225
  Stands:
    On Indian lands 612
    Present distribution 174
    Present volume 174
    Present volume (charts) 174–7, 190
  Sustained yield volumes (table) 229
  Total stand, hardwoods and softwoods (table) 176
Scenic areas for recreation 471
Schnur, Luther G., coauthor 1509
Schools, forest:
  responsibility for forestry 1598
  (*See also* Forest Schools.)
Seasoning, forest products, research 1374
Second-growth:
  Saw timber stand, United States (charts) 175–6
  Timber areas (chart) 128
  Total stand (table) 176
Secretary of Agriculture, letter of transmittal from 3a
Seed:
  Forest, testing and certification 1506
  Improvement work, suggested organization for 1494
  Source of:
    Importance in forest planting 1494
    Influence on disease conditions 698–699
  Trees:
    Douglas fir type as related to devastation 1433
    Hardwoods 1449
    Sugar pine-ponderosa pine 1440
Selection cutting:
  Douglas fir type as related to devastation 1433
  Sugar pine-ponderosa pine 1440
  (*See also* Selective cutting.)
Selection forest (chart) 905
Selection and grading of forest products, research in 677, 1373
Selective cutting 904
  Application to southern properties 953
  Of Douglas fir 917
  As an element of intensive forestry 1459
  Of southern pines 952
  Stumpage realization values (table) 908
  (*See also* Selection cutting.)
Semiarid woodlands and brush lands, erosion problems on 1531
Senate Resolution 57 1b
Senate, United States, resolution requesting report 81
Sheep, mountain, on national forests 493
Shooting grounds, public 509
Shortleaf-loblolly pine—hardwoods type, measures to prevent devastation in 1445
  Table 1452
Show, S.B.:
  Author 1253
  Coauthor 85, 1587
Shrinkage prevention, forest products, research 1369
Silt load of the Arkansas River 404
Silting:
  Channel, West Gulf drainages 361
  Reservoir, following fire 424
Silviculture:
  Private land, distribution of volume on residual stands (charts) 906, 917, 922, 923, 926, 929, 934, 944, 949, 970, 972, 973, 974, 976
  Profitable, examples of 1473, 1474
  Progress in, on national forests 582
  Systems 904
Silvicultural practice, Indian forests 621
Silvicultural requirements of forest-land owners 1002
Slash disposal:
  Compulsory, State 823
  Douglas fir type as related to devastation 1434

Slash disposal—Continued Page
  Hardwoods 1449
  Larch-fir type 1438
  Ponderosa pine type 1442
  Private land, needed to prevent devastation (table) 1451
  Softwoods 1446
  States providing for regulation (map) 998
  Sugar pine-ponderosa pine type 1440
  Spruce-hemlock fog belt, relation to devastation 1432
  Western white pine type 1436
Smelter fumes:
  Disturbance of forest cover, effect on streamflow and erosion 325
  Erosion from areas devastated by, Columbia River Basin 452
  Kennet area in California devastated by, erosion conditions on 423
Smith, Herbert A., coauthor 733
Snow melt retarded by forest cover 308
Society of American Foresters, survey of private commercial forests 896
Social benefits, full realization of, a major forestry objective 41
Society for the Protection of New Hampshire Forests 8
Social values of wild life 491, 493
Soda pulping process, wood requirements (chart) 269
Softwoods:
  Cordwood stand (table) 181
  Lumber, world exports, postwar (table) 291
  Measures to prevent devastation in 1446
  Table 1452
  Production, 1899–1931 (table) 247
  Requirements 257
  Saw timber stand 174–177
    Eastern and western, total (table) 179
    Present and proposed (chart) 226
    Total, United States, (charts) 174–177
  Total stand, all timber 184
  Table 176
  Used for paper, stand (table) 182
Soils:
  Arkansas and Red River drainages 406
  Evaporation from, reduced by forest cover 309
  Forest:
    Absorptive capacity of 312
    Humus content of (table) 311
  Freezing, influence of litter on 313
  Lower Mississippi River Basin, erosibility of 414
  Ohio River Basin 300
  Upper Mississippi River Basin 372
  (*See also* Erosion.)
South:
  Forest planting needs 1504
  Opportunities for intensive forestry 1476
  Private forest conditions and management 939
South Atlantic drainages:
  Character of forest as influencing watershed conditions 347
  Climate and physiography 341
  Erosion 342
  Floods 346
  Navigation 345
  Water power 345
  Water supplies, urban 346
South coast drainages, California, watershed conditions in 425
South Rocky Mountain region:
  Significance of Federal cooperation in 1074
  State aid in 1200
Southern Appalachians, erosion in 344
Southern forest range lands 547
Southern States:
  Agricultural land abandonment in 161
  Forest problems in 739
  Significance of Federal cooperation in 1072
  State aid in 1196
  Tax delinquency 877
Spain, regulation of private forests 1031
Sparhawk, W. N.:
  Acknowledgment to 173, 1253
  Author 993, 1343
  Coauthor 85, 279
Speed of attack, vital need of State fire organization 818

Page

- Spruce-fir type, measures to prevent devastation in, 1443
- Spruce-hemlock fog belt type:
  - Measures to prevent devastation in, 1431
  - Practices needed to prevent devastation in (table), 1451
- Spruce pulpwood requirements (chart), 268
- Stain, injury to forest products by, 707
- Stands:
  - All timber, 184
  - United States (chart), 178
  - Indian forests (table), 612
  - Remaining, availability, summary, 23
  - Saw-timber:
    - Having conversion value (chart), 190
    - Ownership (table), 185
    - Present and proposed (chart), 226
    - Timber, world's, decreasing, 295
    - United States (charts), 174–8, 186
- Stand tables:
  - Bottomland hardwoods, lower Mississippi Valley, 951
  - Douglas fir, western Washington, 920
  - Longleaf and slash pine, Florida, 950
  - Northern hardwoods, White Mountains, 970
  - Oak hardwoods, Mont Alto State Forest, 974
  - Ponderosa pine, eastern Oregon, 930
  - Red spruce, White Mountains, 972
  - Shortleaf and loblolly pine, southern Arkansas, 946, 947
  - Sugar pine, California, 927
  - Western white pine, Idaho, 936
  - White pine, hemlock, and hardwoods, Pennsylvania, 977
- State accomplishments and plans (section), 733
- State agricultural experiment stations, forest research by, 796
- State aid:
  - Federal forest-insect activities as a form of, 1139
  - Federal forest pathology activities as a form of, 1135
  - Federal program, proposed, legislation needed, 1632
  - Forest Service research as, 1140
  - Forestry, program for, 1601
  - In forestry, summary, 6
  - Necessity for, reduced by forest productivity, 113
  - To private owners and local political units (section), 1177
  - Program of, State expenditures involved (table), 1607
- State contribution to forestry, summary, 5
- State, county, and town share in fire costs (table), 819
- State-Federal aid:
  - Future expenditures 1933–39 (table), 1340
  - Protection, insects, 1336
  - Indirect, 1330
  - 20-year program (table), 1341
- State fire protection:
  - Federal aid in, 1332
  - Organization, 818
  - Regulation, 1350
- State forests:
  - Area (tables), 825, 1264
  - Definition, 824, 831, 833
  - Development of, in Pennsylvania, 763
  - Income from, 1326, 1636, 1638
  - Management costs, 1318
  - And parks, summary of, 6
  - Program for, 1603
  - Reforestation program for, 1606
  - Regional concentration, 839
  - Visitors to (table), 464
  - Western, areas, 840
- State forest land:
  - Administration, 823, 832, 834
  - Not in forests and parks (table), 826
  - Ratio to all commercial (table), 827
  - Tax reverted, 829
  - Used by game, 507
  - Watershed protection conditions and requirements, 1516
- State forest planting, regulation, 1350
- State forest research, 1569
  - Program, summary, 56
- State forestry, organization for, 1600
- State forestry organizations:
  - Need of civil-service status, 816
  - Present status, 778
- State game commission, 1553
- State game refuges and hunting grounds, 830
- State land:
  - Fire control, allowable burn (table), 1399
  - Forest wild life areas on, 1552
  - Private land, fire-protection costs (table), 1408
- State legislation required, national plan, summary, 74
- State and local governments, responsibility for forestry, 1599
- State management of forest lands, relative financial capacity (table), 1297
- State organizations for forestry, summary, 5
- State parks:
  - Area (table), 825
  - Definition, 824, 831
  - And forests, administration, summary, 483
- State participation in national forest income, 1326
- State range lands, western, 546
- State regulation:
  - Of private owners, 822
  - Scope, 1345
- State responsibility:
  - In fire-control program, 1405
  - Public regulation, 1344
- State taxation regulation, 1350
- Steer, H. B., author, 607
- Stewart, George, acknowledgment, 527
- Stock. (*See* Livestock.)
- Stock, forest planting:
  - Distribution by regions 1930 (table), 1079
  - (*See also* Planting Stock.)
- Stock, growing. (*See* Growing Stock.)
- Stocking:
  - Deficiency in cut-over California and southern softwood stands (table), 866
  - Deficiency in cut-over hardwoods (table), 863
- Stone, J. H., coauthor, 489
- Straw, consumption in paper manufacture (table), 259
- Streams heading in national forests (map), 589
- Stream flow:
  - Affected by logging, 321
  - Conditions:
    - Hudson Bay drainage, 368
    - Upper Mississippi River Basin, 370
  - East Gulf drainages, 351, 354
  - Forest influence on, foreign laws recognizing, 328
  - Forest planting for regulation of, 1489
  - Influence of forest cover on, study in Clearwater River drainage, 453
  - Ohio River Basin, 387
  - Power development from, 302
  - (*See also* Run-off, watershed.)
- Stream-flow erosion, research by Forest Service, 1563
- Stream-flow problems:
  - Critical, Appalachian Mountains, 1527
  - In lower Mississippi River Basin, 413
  - Magnitude of, 300
  - West Gulf drainages:
    - Character of flow, 360
    - Floods, 360
    - Silting of channels, 361
    - Stream-flow utilization, 360
- Stream-flow regulation, a program for, 1509
- Stream-flow and water conservation on national forests, 589
- Structure, wood, research, 1386
- Stumpage:
  - Private, Federal acquisition, future supply, 1284
  - Western, classification of, on conversion basis, 1157
- Stumpage price trend, Southern yellow pine (chart), 942
- Stumpage realization values, selective cutting (table), 908
- Stuart, R. Y., forester, signature, letter of transmittal, x
- Subsidies, present public, influence on permanent ownership of private industrial timberland, 1269

Page
Sugar pine-ponderosa pine type, measures to prevent devastation 1439
  Table 1452
Sugar pine, typical stand, California (table) 927
Sulphate pulping process, wood requirements (chart) 269
Sulphite pulping process, wood requirements (chart) 269
Summary:
  Of arguments for and against public regulation 1047
  Of expenditures for private forest research 992
  Historical, of forest taxation legislation 800
  Of progress in State forestry, 1885–1911 766
  Of report on S.Res. 175 1
  Of results of Federal aid in forest-fire protection 1074
  Of State forestry movement, 1819–85 742
Summer range on forest land 537
"Superlative areas" for recreation 471, 485
Supervision required in research 668
Supply, future timber, Federal acquisition, private stumpage 1284
Surveys:
  Fishery 524
  Forest and economic, by States 1184
  Forest, national program, proposed 1617
  Land classification 1246
Sustained yield:
  Essential for permanent communities 110
  Forest products, selective logging 1360
  Possibilities (table) 228, 229
  Selective logging research 1378
  Under three management plans 242
Sustained-yield management, private:
  New England and Middle Atlantic States 968
  Pacific coast 911
Sustained-yield practice, extent on private forest lands 896
Sweden, regulation of private forests 1032
Switzerland:
  Example of forest management in 906
  Regulation of private forests 1034
  Wood use 286

T

Tanganyika, regulation of private forests 1035
Tanning, raw materials for 555
Tax delinquency:
  Causes 880
  Idaho (table) 875
  Lake States 876
  Land acquisition through 1250
  Oregon (tables) 873, 874
  Other regions and States 879
  Private ownership break-down 870
  Reason some land remains private 883
  Southern States 877
  Washington (table) 875, 876
  (*See also* Abandoned lands, Abandonment.)
Tax reversion:
  Delinquency, extent 872
  Future trends 887
  Private ownership break-down 871
Tax-reverted forest land, problems of, summary 21
  Lake States 835
  State 829
Tax-title lands, present provision for disposition, examples 885
Taxation:
  Effect of productive forests on 112
  Forest. (*See also* Legislation, Forest taxation.)
    History of legislation 800
  In State forestry policies 800
  State regulation 1350
Telephone lines, Indian forests (table) 626
Thinning, as an element of intensive forestry 1456
Ties. (*See* Crossties.)
Tillotson, C. R., author 843, 733
Timber, adequate provision for, summary 43
  Annual commodity cut (table) 214, 215
  Annual cut, consumption, and growth (table) 1205
  Availability 189
    Summary 24
  Budget, problem of balancing, summary 22

Page
Timber, Consumption, European, trends 283
  Cut (table) 210, 211
    Annual (chart) 13
    Or destroyed annually (table) 206, 208
    Indian lands (table) 613
    Russia 287
    Use, and growth (chart) 239
Drain. (*See* Drain.) (Charts) 206–211
  Exports, world trends in (tables) 290
  Foreign supplies in relation to markets 240
    Great Britain, imports by (table) 284
  Growing job, public and private (chart) 69
  Growth 220
    Chart 24
  Holdings, small, production forest products 1361
  Indian lands, volume 613
  Investment, earnings due to growth (table) 909
  Killed, deterioration of 706
    Disease, insects, etc. (table) 219
    Fire annually (table) 218
  Losses 218
    Due to insects 724
  Management, extensive, areas, summary 43
    Public domain 640
    Forest Service program, proposal 1620
    Intensive, areas, summary 43
    Plans on national forests 580
  Ownership 184
    Private acreages, Pacific coast 911
Timber production:
  Areas available for 149
  Areas needed for, summary 43
  In East, balancing grazing with 554
  Forest planting for 1490
  Intensive methods of 1455
  Land available for 125
  Land needed for 1235
  National-forest acquisition for (table) 576
  Public domain 640
  Wild life and 497
  (*See also* Intensive forestry.)
Timber requirements:
  Area needed for (chart) 48–49
  Estimated growth necessary to meet (table) 232
  Growing stock needed to meet (table) 233
  Our national 245
  Normal, present and future 84
  Versus supplies 235
Timber resources (chapter heading) 171
  Present and potential 173
  World, decreasing 295
Timber, returns, national forests 1323
  Saw. (*See* Saw timber.)
  Sawed, production by States (table) 1206
Timber stand of United States 184
Timber supply, interdependence of States 1205
  Regional interdependence 237
Timber use on national forests 579
  World use in construction 294
Timberland(s):
  Cut-over, abandonment 881
  Indian reservations 607
  Industrial, area, future 1271
  O. & C. and Coos Bay land grants 647
  Old-growth and second-growth (chart) 128
  Private industrial, factors influencing permanent ownership 1265
  Uncut, abandonment 882
  (*See also* Forest land.)
Topography:
  Arkansas and Red River drainage 405
  East Gulf drainages 352
  Ohio River basin 378
Town forests (table) 843, 845
Training:
  Fire fighting, State organization 818
  Personnel, needed in research 665
Transpiration, canyon-bottom vegetation, California 426
Transportation, as an element of intensive forestry 1464
  Forest products 1358
Trees, distributed to farmers (table) 1078
Trends, consumption, meeting the challenge 1393
  Future, tax reversion, forest land 887
  Regional, influence on permanent ownership of private industrial timberland 1267

Page
Trends, world wood consumption (section heading) 279
Tribal lands and forestry 618
Tropical forest research, private and quasi-public 985, 988, 990
Tropical Plant Research Foundation 988
Tugwell, R. G., Assistant Secretary, signature, letter of transmittal x
Turkey, forest regulations 1035
Turpentining, longleaf-slash pine type 1445
(*See also* Naval Stores.)

U

Unallotted Indian forest lands, areas (table) 611
Unemployment, forest planting as mode of relief 1492
United States, forest regions and types (map) 123
Universities:
  Forest research by, endowed 986
  Responsibility for forestry 1598
Upper Mississippi River Basin (map) 371
  Watershed conditions 369–376
Upper Rio Grande Basin (map) 431
  Watershed conditions 438–440
Use:
  Land. (*See* Land use.)
  National forest resources, correlated 577
  Timber versus cut and growth (chart) 238–239
  Western range, seasonal 542
Utilization:
  Forest products, as an element of intensive forestry 1463
  Lumber, in construction 249
  Timber, wild life in relation to 497
  Values, positive, saw-timber yields based on (table) 229
  Wood:
    Modern 281
    Prior to industrial era 280
    Program, extension of, summary 50
  Research:
    Fundamental 1391
    Mill waste 1385

V

Veneer, world production 294
Virgin timber. (*See* Old-growth timber).
Visitors to forest land (table) 464
Volume, tree, converted to mill tally (chart) 953

W

Wall board. (*See* Board, wall.)
Wallace, H. A., Secretary, signature, letter of transmittal x
Water:
  Conservation:
    Indian forests 623
    National forests 589
  Consumption by forest vegetation 310
  Navigation facilities, Federal expenditures on 303
  On western ranges 543
  Streams heading in national forests (map) 589
  Supply, problems of:
    Columbia River Basin 453
    Great Basin 444
    Northeastern drainages 333
    Ohio River Basin 383
    South Atlantic drainages 346
    Southern California 425
  (*See also* Precipitation, Evaporation, Runoff, Percolation.)
Water power:
  Colorado River Basin 432
  Columbia River Basin 453
  Northeastern drainages 334
  Ohio River Basin 385
  Pacific Cascade drainages 458
  South Atlantic drainages 345
Watershed conditions:
  Arkansas and Red River drainages 407
  California drainages 420
  Colorado River Basin 430
  Northeastern drainages 331
  Ohio River Basin 387

Watershed conditions—Continued Page
  Upper Mississippi River Basin 370
  Pacific Cascade drainages 458
  And requirements correlated with land ownership 1512
  Upper Rio Grande Basin 438
Watersheds:
  Forest areas influencing (chart) 28, 78
  Forest protection of, foreign laws recognizing 328
  Forests as a protection of 139
  Grazing on 536
  Income, national forests 1325
  Major, United States (maps) 331, 332, 341, 351, 359, 371, 379, 396, 419, 431, 445, 451
  Streams heading in national forests (map) 589
Watershed protection:
  Acquisition program, summary 52
  Adequate land-management requirements 1532
  Forest areas classified as to 1509
  Forests classified as to 329
    California 438
    Colorado River Basin 430
    Columbia River Basin 451
    Great Basin 449
    Upper Rio Grande Basin 440
  Forest planting for 1488
  Forest Service research program, proposed 1617
  A function of forests 299
  Indian forests 623
  Land needed for 1234
  Major critical situations 1521
  Measures needed for:
    Arkansas and Red River drainages 411
    Northeastern drainages 340
    Upper Mississippi River Basin 376
  National-forest acquisition for (table) 575
  Needed on public domain 643
  Need for regulations 1043
  Needs, West Gulf drainages 364
  Problems, summary 25
  A program for 1509
  Program, summary 51
  Public-domain areas of value for 639
  Recognized by law as function of forests 305
  Relation of forest disease to 705
  (*See also* Protection, watershed.)
Washington, tax delinquency (table) 875, 876
Waste, woods, resulting from lack of coordination 899
Watts, Lyle F., author 637
  Coauthor 1485, 1509
Weather Bureau:
  Forest fire weather research program for 1568
  Forestry program, proposed 1614
Weather, forest fire, research in 1568
Weeding, as an element of intensive forestry 1456
Weeks Law:
  Acquisition under 1171
  Effect on State forestry 776
  Introducing new national-forest policy 571
  Provisions for Federal aid in fire protection 1054
Weevil, white pine 729
West Gulf drainages (map) 359
  Character and extent of forests as affecting watershed conditions 362
  Character of stream flow 360
  Climate 359
  Erosion problems 361
  Floods 360
  Forests:
    Character and extent 362
    Relation to watershed problems 363
  Silting of channels 361
  Stream flow utilization 360
  Watershed needs 364
Western forests, measures to prevent devastation (table) 1430, 1451
Western forest ranges, principles of management 540
Western larch-western white pine type, measures to prevent devastation (table) 1435, 1452
Western States:
  Development of national forests in 1170
  Forest problems in 740
Western white pine, heavy stand, Idaho (table) 936
Western white pine type, measures to prevent devastation 1435

Page
White fir, decay in, rate of increment (chart) 703
White pine blister rust. (*See* Diseases.)
White pine, virgin stand, Pennsylvania (table) 977
Wild life, management:
  Areas usable for (table) 502
  Big-game population (table) 493
  Conservation, proposed Federal program, legislation needed 1632
  Dependence on forests 489
  Depletion of, summary 31
  Economic and social values, summary 30
  Estimate of value (table) 495
  Forest land used by 505
  Forest problems, summary 30
  Forest, research 1553
  A forest resource (section) 489
  In Indian forests 623
  Land needed for 1235
  Management:
    Development of 501
    Summary 30
  Preservation on national forests 593
  Production relation to other forest uses 497, 538
  Program 54, 1547
  Social and economic values 492, 494
  In State forests 830
  Supply 505
  (*See also* Forest wild life, game.)
"Wilderness areas" for recreation 473, 476, 485
Willow blight 713–714
Winslow, Carlile P., author 1355
Wood:
  Advantages of domestic supplies 91
  Competition of other materials with 251
  Consumption in minor products (table) 275
  Consumption, world trends in (section heading) 279
  Destroying organisms, research 1390
  Forests as a source of 91
  Fuel, consumption 272

Wood—Continued Page
  Imports, Great Britain (table) 284
  Preservation, research in 991
  Requirements for paper (chart) 267
  Use:
    Constant changes in 292
    European, trends 283
    In modern times 281
    Prior to industrial era 279
    World 283, 294
  World need continuous 296
  World supply decreasing 295
  (*See also* Forest products.)
Woodland:
  Areas (charts) 130, 132, 136
  Effects of overgrazing on 325
  Farm, area and condition 136
  On farms, future ownership 1276
    Table 1278
  Overgrazing, effect on watershed 554
  Semiarid, watershed problems 1531
  (*See also* Farm woodlands.)
World production of pulp and paper 293
World trade in wood, trends in (tables) 290
World War, effect on timber exports (tables) 290
Wurttemberg, protection forests in 1020

Y

Yale School of Forestry, research by 986
Yazoo Delta:
  Flood, measurements of run-off and erosion 416
  Floods in 413
  Measures needed for flood control 417
Yield:
  Commercially important conifers (table) 903
  Saw-timber, theoretical, 1950 (table) 229
  Sustained. (*See* Sustained yield.)
Yugoslavia, regulation of private forests 1035

Z

Zon, Raphael, coauthor 279

○